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CONDY'S

PATENT

FLUID

PURIFIES, DEODORISES, and DISINFECTS, by the agency of NASCENT or OZONIC OXYGEN,—its active principle.

Being entirely INNOXIOUS, this truly scientific preparation is peculiarly adapted for the following useful purposes, for which all OTHER DISINFECTANTS, on account of their POISONOUS or otherwise objectionable qualities, are unavailable :—

Detecting organic impurities in air and water.
Purifying drinking and other water from organic matter, lead, &c.
Freshening the air of close places, and removing bad smells.
Freeing meat, fish, butter, or other provisions from taint.
Counteracting the effects of organic poisons taken into the stomach.
Curing musty provender. Freeing wheat and other seeds from smut.
Maintaining the health of plants in pots and conservatories.
Preserving and restoring the freshness of cut flowers kept in water.
Destroying the blight of the potatoe, vine, hop, mulberry-tree, &c.
Washing dogs and other domestic animals.
Cleansing bottles, beer barrels, pickling tubs, dairy utensils, &c.
Washing the hair and darkening its colour when turning grey.
Enhancing the purifying and invigorating effects of baths and tubs.
Dressing poisoned wounds and destroying animal virus.
Treating the infectious diseases of cattle, horses, dogs, &c.

N.B.—For all of the above objects, except those named in the three last lines, CONDY'S FLUID *must be used diluted with water in the proportion of a tea-spoonful to a pint. When duly diluted, this fluid does not stain. Stains caused by the undiluted Fluid are easily removed by means of Lemon Juice or Salt of Sorrel dissolved in water.*

TO PURIFY RAPIDLY THE AIR, USE THE DILUTED FLUID WITH

"Condy's Ozoniser" or other Spray-producer.

By the addition to the strong Fluid of Sulphuric Acid, ozone is evolved.
By that of Hydrochloric Acid, pure Chlorine Gas is disengaged.

PRICES :—

Green:—Half Pints, 6d.; Pints, 1s.; Imperial Quarts, 2s.; Bulk, 5s. per Gallon.

Crimson:—(Purer and Stronger), Half Pints, 1s.; Pints, 2s.; Imperial Quarts, 4s.; Bulk, 10s. per Gallon. (In Bulk, Bottles, 8d. per Gallon.)

H. BOLLMANN CONDY, Battersea, Patentee.

CONDY'S PATENT FLUID,

Or Natural Disinfectant;

THE ONLY CERTAIN AND READY TEST FOR

ORGANIC IMPURITIES IN WATER,

AND AN EFFECTUAL AS WELL AS AN EASY AND ECONOMICAL MEANS OF

PURIFYING TAINTED WATER.

LIEBIG, HOFMANN, FRANKLAND, LETHEBY, SIMON, *and the whole Scientific and Medical World now agree in admitting the efficacy of* CONDY'S FLUID (*Permanganate of Potash*) *for the testing and purification of Water, as first discovered and published by* MR. H. B. CONDY, *in the year* 1856, *as well as for disinfection in general.*

Directions for Testing and Purifying Water by CONDY'S FLUID.

TO TEST THE PURITY OF WATER.—To a tumblerful of the water to be tested, add one drop of Condy's Fluid (Crimson), which will communicate a faint pink hue. On allowing the tumbler to stand some little time, if the pink colour has disappeared, introduce another drop, and again let it stand. The number of drops required to obtain a permanent pink tinge, will be the measure of the organic matter destroyed.

TO PURIFY WATER.—Mix a tea-spoonful of Condy's Fluid (Crimson) with a tumblerful of water, add gradually the resulting mixture to one gallon of the water to be purified, and stir with a wooden instrument. So long as organic matter remains, which is known by the pink colour disappearing, introduce sparingly more Fluid. Let the water stand, and the deposit formed will subside. If the pink tinge is maintained, a little too much Fluid has been used; and, in that case, add a little more of the original water. Even if required for drinking *at once*, without subsiding, no objection can be made to the water on the score of purity, as the slight turbidness is due only to a trace of a substance *not in the least unwholesome*, viz., Peroxide of Manganese.

H. BOLLMANN CONDY, BATTERSEA, LONDON.

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SELECTION

FROM

REPORTS AND TESTIMONIALS

IN FAVOUR OF

CONDY'S FLUID.

ST. THOMAS'S HOSPITAL, *October* 31*st*, 1857.

I have carefully examined the disinfecting and deodorizing fluid manufactured by Mr. Condy, and have found it to be most rapid and efficient in its operation. The facility with which oxygen is supplied by this valuable preparation, renders the almost immediate destruction of odours in sewage a matter of certainty. The same instantaneous action is exerted on those smells which frequently increase disease in a household, and which emanate from imperfectly trapped closets and drains. For domestic use it is peculiarly adapted, from the absence of any odour in the disinfectant itself and from the facility of its application. I have also found it to have a powerful and rapid influence in the removal of the disgusting odour of putrefying flesh and of tainted meat. Water of all kinds which has been contaminated with organic matter, and has thus acquired an offensive smell and taste, is immediately deodorized, purified, and preserved by this valuable deodorizer. I consider it to be a most important addition to sanitary science, and a valuable agent in the hands of the medical profession.

ROBERT DUNDAS THOMSON, M.D., F.R.S.

53, GREAT MARYLEBONE STREET, *September* 3*rd*, 1858.

SIR,—I have refrained from giving any opinion on the properties of your Patent Fluid, until I had given it a full and fair trial; this I have done, having used it undiluted as a detergent and excitant in several cases of disease in the heels and feet of horses, and as a first dressing for foot-rot in sheep. In crowded, close, and ill-drained stables, I have also recommended its use, and in each case with the most marked success. I am just now returned from attendance on a kennel of hounds, in which virulent distemper had broken out; here I used it diluted as a deodorizer and disinfectant, sluicing, washing, and sprinkling everything with it, with an effect far surpassing that of any of the compounds of chlorine I have generally used, as it completely destroyed the offensive smell, without causing the injurious irritation always produced by chlorine on the already irritated mucous membrane of the dogs suffering from this malady.

In short, Sir, I consider it a boon to the veterinary profession and the sportsman, and a benefit to humanity at large.

Yours respectfully,

H. B. Condy, Esq.

W. H. KENT, M.R.C.V.S.

"Another way in which water may be purified, probably well known to most of our readers, is that of Mr. Condy. Solution of permanganate of potash and other bases [Condy's Fluid] when added to water soon oxidises organic matters, sulphuretted hydrogen, and other oxidisable bodies which may undesirably be present in water. The quantity necessary for the purpose is so exceedingly small that the alkali introduced into the water is of no importance, while the manganese is converted into hydrated peroxide, which gradually settles down, or may be removed by filtration."—*Medical Times and Gazette, April* 28*th*, 1866.

"I write to suggest the addition of permanganate of potash [Condy's Fluid] to the water in the Company's reservoirs. Mr. Condy, of Battersea, manufactures this material largely. . . . It is the only thing capable of this application that I should have any faith in. It is quite innocuous, and could therefore do no harm. It is much better than the boiling of water, even if that were possible, for water containing a slight leakage from a water-closet is not deprived of its noxious qualities by being boiled for a short time." *Letter from Professor Frankland to the* "The Times" *on the Prevention of Cholera by the Chemical Purification of Water, August* 9*th*, 1866.

"Lastly, I would suggest a simple method of cleansing the air of the rooms or wards of the sick. Condy's Fluid (solution of permanganate of potash) is certainly one of the

most powerful disinfectants known, and has recently had special attention drawn to it in a supplementary report of the Registrar-General. Now in the beautiful little instrument used for throwing the spray of perfumes through a chamber we have at once a method for purifying the air of a sick room, and by this simple process the atmosphere around the sick might be kept charged with a diluted solution of Condy's Fluid. Larger 'spray-producers' might be used in the wards of hospitals, worked by hand-bellows, and I would strongly urge a trial of this method in cholera wards.

Times, August 11*th*, 1866. SAMUEL RHIND, L.R.C.P., M.R.C.S."

"Mr. Condy has applied condensed oxygen, rendered still more powerful by being also nascent, to the disinfection of putrid matter, and by a happy scientific idea has produced a very beautiful liquid, completely destructive of putrid matter."—*Dr. R. Angus Smith, at Meeting of the Society of Arts, 22nd April*, 1857.

"Condy's Fluid is very different from carbolic acid, and for this reason, that it oxidizes substances with which it comes in contact. It destroys the smell, perhaps, more rapidly than any disinfectant, and is extremely elegant as well as effective."—*Evidence of Dr. R. Angus Smith before the Commission of Enquiry into the Sanitary State of the Army in India* (1862).

"Of the soluble oxidizing disinfectants the alkaline manganates and permanganates are the best examples, and in this cursory sketch attention may be confined to these as types of their class. A further motive for this selection is, that a medal (the only one for disinfectants,) has been awarded by the Jury to Mr. H. B. Condy, as the first manufacturer of the manganates and permanganates upon an extensive scale, for disinfecting purposes. The reporter (Professor Hofmann,) has had many opportunities of satisfying himself of their efficacy as disinfectants. . . . By careful manipulation the operator may completely free water from organic impurity, introducing into it, in exchange, only a minute quantity of an alkaline carbonate. This is rarely an objectionable, frequently rather a serviceable, addition, especially in the case of hard waters, which are thus softened.

"The innocuous character of these substances is not the least valuable of their properties. It permits of their being used for a variety of purposes, to which disinfectants have hitherto been almost entirely inapplicable. Among them are some of great value, such as disinfection of all parts of the living animal body (deodorization of the breath, disinfection of ulcers, wounds, &c.) Scarcely less important is the service they are capable of rendering to the vegetal organism, when suffering from blight and similar pernicious influences. They may also be advantageously employed for the purification of tainted provisions, &c."—*Report by the Juries of the International Exhibition*, 1862, *Class II., Section A.; Chemical Products and Processes*, page 108.

"The air test recommended by Dr. R. Angus Smith, Miss Nightingale, and others, is the alkaline permanganates, or 'Condy's Fluid,' which, besides, is itself a vehicle of ozone, and, as a free contributor of it, is in extensive use as a sanitary agent identical in its nature with the very ozone of the atmosphere itself—the great scavenger and cleanser of nature."—*The Builder*, 6*th July*, 1861.

MUNICH, *July* 19*th*, 1862.

I have myself made a series of experiments which have convinced me that the statements about the excellent effects of Condy's Fluid in destroying bad smells, as well as the unwholesome contaminations to which drinking water is subject, are perfectly correct. It has proved itself of very great service for purifying the mouth, and washing the feet and other parts of the person. I consider it an inestimable means for the preservation of the health. (Signed) J. LIEBIG.

ROYAL COLLEGE OF SURGEONS, *December 2nd*, 1862.

I have much pleasure in bearing my testimony to the superior qualities possessed by Condy's Fluid as a disinfectant. During the time I held the appointment of Surgeon Superintendent in the Government Emigration Service, I used it largely and frequently. On one occasion when fever was raging on board, I submitted it to an extensive series of comparative trials with the well known disinfectants, Chloride of Lime and Chloride of Zinc; and the conclusion I arrived at was, that Condy's Fluid was the most efficient. My success in losing only one patient, when upwards of forty were attacked by fever and measles, I particularly attribute to the anti-contagious and anti-infectious properties of this valuable fluid.

(Signed) WM. DOMETT STONE, M.D., M.R.C.S.

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AIR AND WATER:

THEIR

IMPURITIES AND PURIFICATION.

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THEIR

IMPURITIES AND PURIFICATION,

BY

HENRY BOLLMANN CONDY.

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PREFATORY NOTE.

The main facts stated in the following Essays, and the reasoning founded thereon, have for many years been floating in my mind in a state of partial development. There they might still have remained, but for the literary assistance of a valued medical friend, whose editorial supervision has been such as might have fairly entitled him to put his name to the work.

H. B. CONDY.

Battersea, Surrey, *August*, 1862.

" There is no more real or tangible benefit which you can confer on a people, than to reduce the rate of mortality and lessen the amount of disease . . . . Every doctor will tell you that an immense saving of life would take place, if only some three or four simple things were estimated at their true value—pure air, pure water, sufficient drainage, and healthy bodily exercise for those who lead sedentary lives." Lord Stanley on Popular Physiology."—*Medical Times and Gazette*, Nov. 9, 1861.

" And neither is it contaminated air alone which is productive of such fevers; for water similarly poisoned by decomposing animal or other organic matter is productive of the like evils; and the immense importance of pure air and pure water is becoming more and more fully appreciated by medical authorities and by the public in general."—*The Builder*, Jan. 11, 1862.

" The full access of all healthful stimuli to the surface, and freedom from all that irritates or impedes its functions, are the first external conditions of the normal vigour of this nervous circle. Among these stimuli, fresh air and pure water hold the first place. The great and even wonderful advantages of cleanliness, are partly referrible to the direct influence of a skin healthily active, open to all the natural stimuli, and free from morbid irritation upon the nerve centres of which it is the appointed excitant. This influence is altogether distinct from those cleansing functions which the healthy skin performs for the blood."—*Cornhill Magazine*, Feb. 1862, pp. 165-6.

" With regard to the question of general management [in surgical injuries] the single fact of cleanliness, if taken in its largest sense, will shut out nearly all the mischiefs that come from without; but that cleanliness must be cleanliness of person, of air, of water, and of everything that may come near the wound."—Address in Surgery, by Mr. J. Paget, at annual meeting of British Medical Association; *Medical Times and Gazette*, Aug. 16, 1862.

AIR:

ITS IMPURITIES AND PURIFICATION.

AIR:

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AIR is the chief necessary of life, and respiration the first and last act of our existence as independent beings. The necessity for due supplies of food, however imperative, is one that admits of modification; life, and to a certain extent health, are not incompatible with an occasionally scanty and irregular allowance of nourishment. But the essential conditions of respiration are that it shall be never-ceasing and unrestrained. Each inspiration exerts its influence instantaneously, and with the expiration which follows, its action terminates. The air we breathe surrounds us, accordingly, on all sides, in inexhaustible quantities, and is drawn upon by every human being, without thought or effort, at the rate of from fifteen to twenty respirations per minute. Unlike food, which in order to be able to support the numerous tissues of the body must be supplied of various kinds, air, to be fitted for its assigned duty, demands no precaution beyond that of guarding against contaminations of foreign matter; for in all situations on the globe, and at every elevation within our reach, the free mass of the atmosphere maintains a uniform composition so far as its essential elements are concerned.

The fundamental basis of the atmosphere is that mixture of gases which is more particularly understood by the term "atmospheric air." This familiar compound is composed, within a fraction, of four measures of nitro-

gen and one of oxygen intimately inter-diffused. The circumstance that each of these constituents preserves its peculiar properties, only slightly modified by the presence of the other, sufficiently proves that they are not chemically combined, but united in the form of a definite admixture. Viewed in reference to the part it plays in the support of life, atmospheric air may be considered to possess the sensible properties of oxygen, which as compared with its other essential element, alone performs the duty of an active principle.

Associated with those fundamental components, are found, in variable proportions, certain other diffusible bodies which appear to be essentially necessary to the constitution of the atmosphere—namely, carbonic acid, aqueous vapour, ammonia, and ozone. Of these, carbonic acid, which is the least variable in amount, is estimated by the best authorities to be present in the proportion of, at most, one part in 1,000. The quantity of aqueous vapour contained in the atmosphere, varies from $\frac{1}{3}$ to 2 per cent., according to the temperature and other circumstances, such as the greater or less humidity, of the surface, and the character and amount of vegetation in each locality. Ammonia and ozone are still more variable in quantity: they are found but in very feeble proportions, occasionally so minute as to escape detection. Aqueous vapour and ozone can hardly, under any circumstances, be regarded in the light of atmospheric impurities; but the other two secondary ingredients, namely, carbonic acid and ammonia, more especially the former, when present in excess, constitute very deleterious contaminations.

Besides the essential ingredients of which it is composed, the atmosphere contains minute portions of all substances susceptible of remaining aëriform at ordinary degrees of heat and pressure, as well as of every matter, whether solid or fluid, which is capable of being dissolved or suspended in the atmospheric mixture. These may be

regarded rather as accidental than normal constituents. It is they which for the most part constitute the contaminations of the atmosphere.* With few exceptions they are substances of an oxidizable nature. They consist of a great variety of more or less diffusible products, such as the gases generated by combustion and similar processes; traces of nitric, acetic, and sulphurous (or rather sulphuric) acids, of nitrate, acetate, and hydrosulphate of ammonia, and in certain maritime situations, of muriatic acid and iodine; exhalations from the organic kingdoms, morbid emanations from men, animals, and plants, when suffering from disease, and the results of their decomposition after death; as well as of numerous forms of more or less tangible solid substances, such as carbonaceous matter, infusoria and other microscopic organisms, pollen of plants, spores and germs of some low order of living beings, and finely subdivided inorganic matter. As even the latter group of bodies are invisible to the naked eye in ordinary diffused light, none of the above substances can be regarded as cognizable to the senses, except when they naturally possess or happen to acquire odorous properties. They then become perceptibly offensive, and cause the atmosphere in which they exist to be distinguished as "bad" or "foul." It is principally the truly gaseous class of impurities which are possessed of smelling properties, although, on the one hand, some of them, and those not the least deleterious, such as carbonic oxide, are devoid of odour; and on the other, some of the less diffusible atmospheric contaminations, such as ordinary bodily exhalations, which are not commonly perceptible to the nose, can be distinguished by persons of more than usual acuteness of smell, especially when proceeding from the bodies of the sick. The effluvia which certain wild animals leave on their tracks, and

* Boussingault; *Comptes Rendus de l'Académie des Sciences* (1853) vol. xxxvii, p. 798.

which constitute the "scent" of the hunting field, afford a familiar example of the latter substances. In the parliamentary report which he drew up, in 1847, on the subject of disinfectants, Dr. Leeson succeeded in showing very clearly, that there is no necessary relation between the odorous and deleterious properties of atmospheric impurities, and that merely to deodorise is not necessarily to disinfect. With reference to this point he classifies the elements of morbid animal exhalations and malarious and putrefactive vapours, as follows:—

Dangerous, but inodorous.	Odorous, but slightly offensive.	Most offensive, but not infectious.
Remittent miasms	Ammonia	Sulphuretted hydrogen
Typhoid miasms	Carb. ammon.	Phosph. hydrogen
Carbonic oxide	Cyanogen	Carburetted hydrogen
Carbonic acid	Sulpho-cyanogen	Sulph. ammon.

That the atmosphere contains a considerable amount of tangible matter is clearly seen, when a ray of sunlight happens to penetrate by a small opening into an obscure place. It then becomes evident, that the air holds in suspension an infinite quantity of solid particles. From this source comes the dust which settles on our furniture, and in rooms which have remained long shut up or uninhabited. This dust is of a very complex character, being composed not only of inorganic matter, but of extremely minute shreds of organised substances derived from the wear and tear of the materials of our clothing and habitations, the articles we eat, the exuviæ of ourselves and domestic animals, and the detritus of plants.* In some of the wards of the Hospital of St. Louis, at Paris, no less than 30% of organic putrescible matter, which on being moistened rapidly exhaled a strong odour of putrefaction, and when calcined smelt distinctly of burnt horn, was recently detected by M. Chalvet in the dust found at-

* Pouchet of Rouen; *Comptes Rendus de l'Académie des Sciences*, t. 1, p. 1122.

tached to the walls, and as much as 46% by M. Réveil. The latter gentleman, by means of the microscope, has succeeded in showing that the air of many surgical wards leaves in the aeroscope, epithelial cells turning yellow under the action of nitric acid, and filaments of lint charged with organic corpuscules apparently derived from human discharges, and has proposed to distinguish the air of hospitals by the term "nosocomial atmosphere."* A very striking instance of the influence of the solid materials which surround us, on the composition of the extraneous matter suspended in the atmosphere, is furnished by the investigations of the last few years on the subject of wall papers coloured with arsenical greens. The dust of rooms hung with these papers, even when collected at very considerable distances from the walls, on being chemically tested, has been found to reveal the presence of arsenic. Moreover, the chronic poisoning by arsenic of persons living in such rooms has been proved experimentally, by an examination of their secretions, especially when the elimination of the poison has been hastened by the administration of iodide of potassium.† In towns the dust which infests our houses in dry weather, is shown by microscopical observations to be, to a very large extent, composed of finely pulverized horse-dung and the grindings of shoe leather.‡ Of the organised substances which are found in common house dust, the most constantly present are perhaps starch granules, which constitute one of the most imperishable forms of organic matter.

The researches of Ehrenberg have sufficiently proved the presence in the air in some localities, of infusorial organisms, as those of L. Pasteur, of Lille, and others have demonstrated, spores of fungi and germs of vibriones to be of frequent occurrence in certain atmospheres. It

* Lectures on Purulent Infection, by Prof. Trousseau; *Revue Médicale* June 30, 1862.

† Dr. Letheby: *The Times*, Feb. 1, 1862.

‡ Lancet, Oct. 19, 1861.

must not however be inferred from such observations, that these microscopic beings are of themselves sources of impurity or capable of reproducing it. On the contrary, they are merely attendants on foulness otherwise derived, and, like confervoid vegetation in water, are, during their processes of life and propagation, sources of the purest oxygen gas.* Unfitted for existing except in impurity, they would seem destined by their mode of being, to act as one of the natural means of purification in circumstances of extreme pollution.

To the group of more diffusible contaminations, belong those emanations of effete matter which are constantly proceeding from organized beings and their excreta, especially during disease, and escaping into the atmosphere. Impurities of this nature are rarely very perceptible to the senses, unless when more than usually concentrated, or in the immediate vicinity of their source. It is probably owing to their presence in the air, that the ammoniacal salts obtained by the evaporation of rain water, which in its fall washes the atmosphere, when tested with lime to set free their ammonia, after the addition of an acid, emit an odour most strongly resembling that of corpses, or the peculiar smell of dunghills.† Even the exhalations which pervade the habitations of men, though of a highly putrescible character, are not, under ordinary circumstances, very cognizable to the senses, except when given off as one or other of the numerous family of volatile alkaline principles.‡ In cold climates, however, like that of Russia, a process goes on during the prolonged winter, which exhibits very clearly the large amount of organic matter diffused in human exhalations. The moisture given off by the lungs and skins of the imprisoned inmates of the dwellings of the lower orders in the north of Russia, is gradually condensed and frozen on

* Liebig's Animal Chemistry, by Gregory, vol. i, p. 216.

† Liebig's Chemistry of Agriculture, by Playfair, 4th edition, p. 403.

‡ Richardson on the Coagulation of the Blood, p. 350.

the insides of the windows, where it is often allowed to remain undergoing a slow process of putrefaction. On the approach of summer the general thaw causes the melting of this deposit, and thereby setting free the products of decomposition, gives rise to certain most offensive odours, for which the abodes of the Russian peasantry, at the breaking up of the ice, are notorious. When the vapour, contained in the air of crowded and overheated rooms, is artificially condensed by means of cold surfaces and collected, it is found to be highly impregnated with matter of an albuminous nature which is extremely liable to become putrid. Moisture so obtained, on being evaporated, gives out a strong smell of perspiration, and the dry residue, when exposed to heat, emits an odour of burning flesh. So charged with azotised matter is the air which we expire, that it is sufficient to breathe through a tube into a jug of water for some little time, in order to obtain a fluid which, on being set aside in a warm place, will readily undergo putrefactive decomposition and disclose the contaminations it contains by its offensive smell. Dr. R. Angus Smith, to whom we owe a great deal in connection with this subject, has estimated that respired air contains 3 per 1,000 of animal matter in the form of a putrescible albuminoid substance. It is with impurities of this nature, that those forms of matter to which we attribute contagion and infection, appear especially to be connected. The announcement made early in 1861 by Dr. Eiselt,* of Prague, of his having discovered, by means of Purkyne's aëroscope, pus-cells in the air of the Orphan Asylum of that city, during an epidemic of purulent ophthalmia, must be considered as tending to prove the occasionally more special nature of the matter by means of which infectious diseases are propagated. We have been prepared the more readily to admit the accuracy of this statement by the experiments

* Wochenblatt Zeitschrift der K.K. Gesellsch. der Aerzte in Wien, No. 13, 1861.

of Pasteur, who found that by condensing and collecting the vapour of water in a focus of suppuration, he rarely failed to demonstrate the presence of irregularly shaped corpuscules, resembling particles of red pus.

Air may be mechanically deprived of many of the foreign matters which it holds in suspension, by a process of filtering through finely-carded cotton. Flesh exposed to the action of air so treated, undergoes decomposition much more slowly than in ordinary atmospheric air, and when decay does supervene, it is unaccompanied by the development of vegetable or animal life.* A somewhat similar effect is known to be produced by passing air through red hot tubes, which, by the combustion they generate, destroy any organic substances present. Air thus purified, when introduced into grape juice, fails to promote fermentation like free air. Results resembling these have been obtained from Dr. J. Stenhouse's charcoal air-filters, which combine a mechanical act of filtration with a certain amount of chemical effect, depending on the presence of condensed oxygen in the pores of the carbonaceous matter.

The atmosphere is therefore evidently subject to very considerable variations in respect to the substances which it contains: in some places and under certain circumstances, it is much more pure than in others. The two extremes are probably to be found, on the one hand, at or near the ocean, which has the effect of absorbing any heterogeneous particles present, and on the other in crowded localities in large towns, more especially in hospitals and places containing large numbers of sick. The air in both of these extremes of purity and impurity, as well as in all the innumerable intermediate conditions, is capable of supporting life, at least for a limited period. It may usually be considered sufficiently pure for the purposes of respiration and animal health, when its chemical

* Schroeder; *Annal. der Chemie und Pharm.*, t. cxix, p. 11.

properties are those of oxygen—that great mainspring of all organic activities. With few exceptions this is the case with the "open air" apart from artificial shelters, where men or domestic animals are more or less closely congregated together. The effects produced on the system by a foul atmosphere, depend in a considerable degree on the state of body, and the constitution and habits of those exposed to its influence; for the air of even the worst ventilated places is hardly ever so impure as to be rapidly destructive to the life of every individual obliged to respire it. The Black Hole of Calcutta itself was not fatal to all of the victims who were barbarously confined in it. Out of the 146 persons who were shut up in that horrible dungeon, twenty-three were taken out alive; but most of the survivors were subsequently attacked with putrid fevers.

It is in connection with the vegetable kingdom, that the most frequent exceptions arise to the rule respecting the wholesomeness of the free external air. Such exceptional cases originate in faulty relations between the soil and the conditions of the atmosphere, as where dense jungles exclude the action of light, and cause stagnation of the air, or extensive swamps impregnate the atmosphere with exhalations inimical to man. A mere profusion of vegetation, when unaccompanied by superabundant moisture, so long as air and light are permitted freely to penetrate, is rarely sufficient to give rise to an impure state of the atmosphere. Those alkaline conditions of the atmospheric mixture which promote the development and growth of low forms of life, encounter a natural antagonism in the respiration of plants, by means of which, water and carbonic acid are decomposed, oxygen evolved, and ammonia transformed into nitric acid; and though M. Boussingault has recently shown, by a series of most carefully performed experiments,* that the green tissue of

* *Comptes Rendus de l'Académie des Sciences*, vol. liii, p. 862; Nov. 1861.

plants, and especially of aquatic plants, has the property, under the action of sunlight, of evolving carbonic oxide and protocarburet of hydrogen, both of which are prejudicial to animal life, there can be no doubt that these products must find an ever-ready and efficient antidote in free air. The admirable antagonism which exists between the animal and vegetable kingdoms, is not one which is ever productive of disturbance: its tendency on the contrary is to maintain the balance of nutrition and health between the two divisions of organized beings—animals giving off carbonic acid and ammonia which are required for the nourishment of plants, and vegetation at certain times exhaling oxygen to be used by animals.

It had long been known that the purest atmosphere was that in which the smallest amount of the more accidental substances was present, and especially such as were of organic origin. Those who had given attention to this subject, had remarked that the atmosphere contains within itself the means of its purification, and by a process of oxidation, converts all organic substances exposed to it into simpler forms of matter, such as water, carbonic acid, nitric acid, &c.;* but previously to the announcement made by Professor Schönbien, to the Munich Academy, in May, 1840, of his discovery of ozone, it was not understood by what particular agency those impurities were oxidized. The investigations of that distinguished chemist, however, by demonstrating the part played by oxygen in its peculiar condition of ozone, have made plain the nature of the process by means of which this object is accomplished.

This indispensable agent, as it occurs naturally, is now almost universally admitted to be derived from the oxygen of the atmosphere and certain electro-chemical decompositions, and to consist of that element freed from its

* Graham's Elements of Chemistry, p. 282.

combinations, and thrown into a peculiar dynamic and allotropic condition of the nature of polarization, by means of those currents of electricity, which are at all times flowing silently through the air. The result of the action of electricity on oxygen is that a certain portion of it undergoes a process of negative polarization, while another portion is simultaneously transformed into an opposite state of polarity. That portion which is negatively polarized is distinguished by the name of ozone: to that which is positively polarized, the term antozone has been given. On coming in contact, these two bodies to a certain extent neutralize one another, and by their combination produce common or neutral oxygen. The comportment of permanganic acid, with peroxide of barium, can only be explained in this way: the superadded atoms of loosely combined oxygen in those two substances, are thrown into opposite states of polarity, and unite to form ordinary oxygen, thus:—

$\overset{+\ -\ -}{Mn_2O_4O_3}$	+	$\overset{+\ -+}{3BaO\ O}$	=	$\overset{+\ -}{2MnO_2}$	+	$\overset{+-}{3BaO}$	+	$\overset{-\ +}{O_3O_3}$ *
permanganic acid.		binoxide of barium.		binoxide of manganese.		baryta.		common oxygen.

In this tendency to union between ozone and antozone, probably lies the reason why it is found impossible to ozonise more than a limited proportion of any given volume of oxygen, however long the ozonising process may be continued. It has been estimated that the amount of ozone capable of being produced, hardly ever exceeds $\frac{1}{1300}$ by volume of the gas operated upon.

Some observers have brought forward this circumstance as one calculated to diminish our confidence in the part which ozone artificially produced, is qualified to perform as a disinfecting agent;† but when we call to

* Schönbein has recently intimated to Mr. Faraday that he has succeeded in obtaining free ozone mixed with common oxygen, by the addition of binoxide of barium to a solution of manganate of potash in sulphuric acid.—*Chemical News*, vol. v., p. 350.

† Dr. Hornidge on Ozone; *Lancet*, April 6, 1861.

mind that few, if any, of the other so-called disinfectants, with the exception of chlorine—itself, after all, possessed of only an indirect action—from which we have been in the habit of forming an opinion respecting the properties of substances used for disinfecting purposes, are truly agents of that nature, we ought to hesitate before admitting the justice of the objection; for it is self-evident that extremely minute portions of a true disinfectant, such as ozone undoubtedly is, must be infinitely more efficacious than much larger quantities of an agent which is possessed of very inferior disinfecting effects. Our confidence in ozone, as *the disinfectant par excellence*, ought to be firmly established by the reflection that, notwithstanding the law which prevents the accumulation of large quantities of it in the atmosphere, and the circumstance that mephitic emanations, miasmatic exhalations, and every gas, vapour and volatile body developed at the surface of the earth, have for thousands of years been escaping into the gaseous envelope which surrounds us, its purity has been constantly maintained without interference with the respiration of animals * These wonderful effects of natural ozone have been moreover explained, and ably illustrated by the experiments instituted by Schönbien, on the properties of oxygen when artificially ozonised, from which it appears that atmospheric air containing but $\frac{1}{3,240,000}$ of that agent, is capable of disinfecting its own volume of air loaded with the miasmata given off, during one minute of time, by four ounces of flesh in a high state of putrefaction, and that an extremely minute portion of ozone is sufficient to discharge the colour of a very large quantity of sulphate of indigo.† It must likewise be borne in mind, that although the maximum of ozone present at one time in a given volume of oxygen is inconsiderable, its pro-

* Prof. George Wilson, on Chemical Disinfectants; *Pharmaceutical Journal*, vol. xii, p. 278.

† Trans. of Med. and Chir. Soc., vol. xxxiv, p. 216 (1851).

duction under the continued influence of electricity or the slow oxidation of phosphorus is uninterrupted, so long as some of that formed is taken up by oxidizable matter. By the introduction of iodide of potassium into oxygen during the process of ozonising, the whole of it may be converted into ozone.* Ozone acts on all organized substances, whatever their condition, but its action on organic matter in the fresh or recent state is comparatively feeble; when decomposition has commenced, however, it manifests the utmost avidity for combination with the more oxidizable products which have been, or are in the act of being formed.

It is thus that electricity operates the restoration to the atmosphere, in a state of activity, of the oxygen taken up by the respiration of living beings, the combustion of fuel and spontaneous oxidation, and its liberation in a condition eminently fitting it for neutralizing the oxidizable and putrescible matters which are continually finding their way into the air. But for this agency, the atmosphere would ultimately become incapable of sustaining life. Ozone is the great scavenging principle of nature. So opposed is it to all foul and effete products of living organisms, that its presence in any given locality may be taken as a proof of the absence of those impurities which render the air unfit for use, and consequently as sufficient indication of the state of the atmosphere, with reference to its fitness for the purposes of respiration, and the maintenance of health.

The importance of being able to observe the variations in the amount of ozone present in the air, has given rise to the use of means for estimating its intensity. When free iodine meets with starch in the moist state, it forms a compound, which possesses a very characteristic blue colour. Ozone having the property of liberating iodine

* Profs. Andrews and Tait, on the Volumetric Relations of Ozone; *Trans. of Royal Soc.*, vol. cl, p. 124 (1860).

from its combination with potassium, by mingling iodide of potassium with solution of starch, a composition is formed which, originally colourless, acquires a blue tint on being exposed to air that has been ozonised. Slips of paper imbued in various degrees with this mixture, are suspended in the atmosphere to be observed, and the changes of colour which occur in them on being wetted after exposure, carefully noted. These and other such contrivances are called ozonoscope papers. Although yet far from perfect, they have undoubtedly contributed much to our knowledge of the economy of the atmosphere.

Numerous observations made by these means in various countries, and by different experimenters, have shown that ozone is most abundant at the surface of the ocean, and on the tops of mountains, and that it is easier of detection when the air is in motion than when calms prevail, during north and east than during south and west winds, and in winter than in summer, especially during falls of snow. It has never been detected inside inhabited houses. In many instances, while the interior of a dwelling has afforded no trace of its presence, the external air close to the windows has manifested it abundantly. Ozone is not found under the shade of the forest. The absence of it from such places, has led to the supposition that the currents of electricity which pervade the atmosphere, being diverted and conducted to the earth by the walls of houses, and the branches and trunks of trees, ozone has no opportunity of being produced in those situations, or, if there evolved, that it is immediately neutralized by the presence of oxidizable matter. A marked coincidence has been observed between the prevalence of certain types of epidemic disease, and the absence or scantiness of ozone in the atmosphere. During the cholera of 1854, ozone was daily detected all round London, whereas no trace of it could be perceived in the more densely populated parts of the metropolis where the

disease prevailed. On elevated ground, it was generally present, but absent in low-lying localities. A marked diminution in the indications implying the presence of ozone, has been very generally observed to precede the outbreak of an epidemic, while the reappearance of those indications has been found to form a very reliable sign of the abatement or cessation of the pestilence.

The original source and medium of propagation of zymotic diseases are involved in considerable obscurity, but there are ample grounds for affirming that they are closely connected with foul and unwholesome conditions of men, and of their food and habitations. Under certain unfavourable social circumstances, such as we find to prevail among some of the less fortunate and more degraded races, as for instance, the fellahs of Egypt, the ryots of India, the negroes of the West Indies, and the lower classes of some European countries, the emanations from the bodies and excretions of men are liable to accumulate in excess of the cleansing power of the local atmosphere, and in that state to undergo transformations, in the course of which, are formed intermediate products of imperfect oxidation which have the property, under certain conditions of body, of producing morbid impressions on the nervous or circulatory system, and catalytic changes in the blood, whose results are the development of zymotic disease. So concentrated sometimes are those unwholesome emanations, as almost to defy the counteracting influence of ordinary ventilation. The plague of the Levant, which is, perhaps, the most perfect example of such diseases, is known to arise among populations, whose dwellings being in general unprovided with glazed windows, must be always more or less open to the admission of the external air. The most recent outbreak of Levantine plague on record, namely, that which occurred in Barca, on the Barbary Coast, in 1858, originated among tribes of nomadic Arabs, without fixed abodes, and whose habitations are tents. Among this people

inhabiting one of the healthiest of countries, and cut off from communication with the rest of the world, by the peculiarities of their position, on an elevated plateau between the desert and the sea, and at a time when plague had been unheard of for fourteen years, the true oriental pestilence fully developed itself with all its worst characteristics. In 1854, an extraordinary drought had caused throughout the Barcan territory a famine, during which thousands of sheep and camels perished. There ensued an outbreak of typhus fever, which, by the fourth year, assumed the type of true plague, and only abated after a very large portion of the population had been cut off. Once engendered, we know it to be in the nature of diseases of this class, to spread beyond the places where they have made their appearance. That the air, within certain limits, is one of the vehicles for the dissemination of the virus, by means of which, they are communicated, is supported by a large amount of evidence. But, though evidently capable of being diffused with the air, the fact that such diseases, in countries where the monsoons prevail, are frequently known to be propagated directly against the course of those winds, proves that the matter on which they depend is of a solid or consistent structure, only partially admitting of being conveyed to comparatively short distances by the air, and that it is also distributed by means of personal intercourse independently of the atmosphere.

While we sometimes see the equilibrium between the purifying power of the atmosphere, and the contaminating effects of bodily emanations upset by an undue development of the latter, in the midst of conditions of ventilation, which are usually highly favourable, at other times, we must suppose similar results to be produced by meteorological causes, which temporarily diminish the neutralizing properties of the air. Of the latter kind of influence, we have, perhaps, an example in the remarkable deterioration which sometimes suddenly occurs in all the

wounds and sores in an hospital, without any assignable cause being apparent, except a marked and unfavourable atmospheric change.* In certain low-lying, densely-crowded, and ill-drained localities, in which those two antagonistic influences may be so equally balanced as to afford no opportunity for the development in excess of the morbific side of the scale, some adventitious change in the electrical conditions of the atmosphere by determining a less copious evolution of the scavenging ozonic principle, may suddenly induce an outbreak of zymotic disease; just as intemperance, want, uncleanness of person, food or drink, associated as they commonly are with overcrowded dwellings, when suffered in an extreme degree, will produce a state of concentrated foulness in excess of the normal neutralizing power of the atmosphere, which must sooner or later engender fevers and other affections of the zymotic class. Whether the diseases so originated shall be typhus, cholera, yellow fever, or plague, will entirely depend on the nature of the country and the race to which the sufferers belong. In such circumstances, it is no longer ozone which predominates, but the downward *un*sanitary scale of organic contaminations. Here ozonoscope papers cease to be available, since they are incapable of affording indications below the ozonic zero. Another method of investigation, based on the employment of some material with properties fitting it for marking the variations in the amount of impurities present in the air, becomes necessary. By means of an oxidizable substance the presence of ozone in the atmosphere can be detected, and its intensity measured: to indicate the presence of oxidizable impurities in the air, and determine with more or less accuracy their amount, it would seem natural to have recourse to some agent containing ozone.

The use in ozonometry of substances liable to altera-

* Miller's Principles of Surgery, pp. 241-2 (Edin. 1850).

tion of colour by contact with ozone, was suggestive of the choice of a body capable of indicating, by somewhat similar appearances, the presence in the atmosphere of matter of a septic nature. Having been for many years engaged in the practical study of the purifying properties of the alkaline permanganates, and being deeply impressed with their extraordinary sensibility to the action of all kinds of impure matter whether solid, liquid or aëriform, I early formed the opinion, that the remarkable change of colour which those salts when decomposing undergo, might be taken advantage of for the estimation of atmospheric contaminations. I had found that when a weak solution of permanganate of potash was left exposed to air impregnated with foul gases, or emanations of an organic origin, it rapidly lost its fine pink colour, and that the greater the amount of impurities present, the more rapidly and completely was this change effected. Here then were the means of recognizing and estimating atmospheric impurities. By exposing solutions of the alkaline permanganates in shallow vessels, I perceived that I could readily detect organic matter in the air, and by observing the degree of decoloration produced in them, form a practical estimate of its character and amount; but as the air in contact with the permanganate was only part of an infinite quantity of impurities belonging to the entire mass of the atmosphere, and its action required to be extended over a considerable period of time, in order to show any result, I could not accurately guage the amount of septic matter contained in any given volume of air at a particular moment. Although in the habit, since the year 1856, of demonstrating the presence of organic impurities in the atmosphere by means of weak permanganate solutions, and of judging comparatively of the average purity or impurity of the air of any place, such as a room or hospital ward, during a certain lapse of time, I had not thought of contriving a definite instrument for applying those substances to the examination of

the local air of the moment. It was reserved for Dr. R. Angus Smith, to be the first to make use of the alkaline permanganates for the latter purpose. Struck with the importance of the facts brought to his notice by me, in April, 1857, some little time previous to the delivery of his lecture on disinfectants at the Society of Arts,* regarding the disinfecting properties of the alkaline permanganates, and their practical applicability to the detection of atmospheric impurities, as well as to the purification of air and water, this gentleman, on subsequently turning his attention to the subject, succeeded in taking advantage of those properties for the comparative measurement of the amount of organic matter present at any particular time and place in a certain volume of air, by the construction of an instrument affording a standard means of comparison.

Provided with this contrivance, to which he gave the name of the "air test," he lost no time in applying it to the elucidation of the subject of the composition of the atmosphere of towns, to which he had already greatly contributed, and which at that time was receiving much attention, on account of its direct bearing on sanitary economy. The well-known and very interesting series of observations, on the comparative amounts of oxidizable matter present in different atmospheres, of which he gave an account, first at the Chemical Society, on 20th May, 1858,† and soon afterwards at the Royal Institution, on 25th March, 1859,‡ was the result of his labours. The air of the town of Manchester, he found on an average of 131 experiments, to require 52·9 measures of permanganate solution to decompose the impurities contained in 100 cubic inches, while that of the country near Manchester, required only 13·7. On the German Ocean, 60 miles from Yarmouth, 3·3 sufficed to take up all the

* Journal of Society of Arts, vol. v, pp. 337-42.

† Athenæum, 12th June, 1858, p. 756.

‡ Chemical Gazette, vol. xvii p. 176.

oxidizable matters present in the atmosphere, whereas the air of an uncovered pigstye was found to neutralize as many as 109·7 measures of the testing solution. Although the conclusions which Dr. Smith was thus enabled to arrive at, were generally received without question, I am not aware that he has yet, by the publication of his testing instrument, afforded the scientific world the opportunity of readily confirming his observations.*

Dr. Smith's air test consists of a wide-mouthed bottle, of the capacity of 100 cubic inches, into which is fitted a stopper of caoutchouc, provided with two tubes, one short and the other long enough to reach to the bottom of the vessel. Through the former the operator withdraws, by means of a suitable bellows-pump, the air contained in the bottle, which is thus replaced by that of the locality where the experiment is being made entering through the latter. A certain measure of a weak solution of permanganate of potash of ascertained and standard strength, is poured into the bottle, and by shaking, brought into contact with the air which has just been admitted. When this is impregnated with matter of organic origin, the permanganate solution soon loses the pink colour which is peculiar to it. A further measure is then added, and repeated till the decoloration ceases, accurate note being

* From not being acquainted with all the facts of the case, and especially that of Dr. Smith's lecture at the Chemical Society, the *Journal de Pharmacie et de Chimie* has claimed the merit of prior invention for M. E. Monnier, who, towards the close of 1858, presented to the *Académie des Sciences*, a memoir on the determination of organic and other oxidizable matters contained in vitiated atmospheres by permanganate of potash. Dr. Smith has, however, clearly earned the credit of having invented and produced a special instrument, by the use of which, substances I first brought under the notice of the public and men of science, as rough but ready means of detecting and removing impurities in air and water, can be employed as accurate air tests. His experiments with the permanganate air test date from the time when I directed his attention to the subject. See *Bull. de l'Acad. de Med.* t. xxvi. p. 1267; *Journ. de Pharm. et de Chim.* t. xxxvi., p. 397; *Comp. Rend. de l'Acad. des Sciences*, t. xlvii, p. 998, December 20th, 1858; *The Builder*, March 2nd, 1861.

kept of the number required, which furnishes the measure of the amount of oxidizable matter present in the 100 cubic inches of air operated on. The strength of the permanganate solution is graduated by a standard solution of oxalic acid, 1,000 grains of which contain one of anhydrous acid: 5 grains of this solution decompose 600 grains of the permanganate solution. As a first attempt at the construction of a graduated measurer of atmospheric impurities, this contrivance of Dr. Smith possesses great interest; but it would require improvement in certain respects, before being qualified to furnish results free from error, or to take its place among philosophical instruments. It is evidently inapplicable for recording the state of the atmosphere as regards organic pollution during the absence of the operator, since results can only be obtained by manipulation. When, for instance, it is required to obtain a register, as it were, of the average quality of the air in a sick room during the night, or a portion of the day, Dr. Smith's air test will afford but little help. An observation might by its means no doubt be made at night, and another in the morning, and thus some information be gained; but in order to make any approach to the truth, the morning's experiment would require to be made before any change whatever, such as the opening of doors or windows, took place in the atmospheric conditions of the apartment.

My original method of working with permanganate solutions in open vessels, is much better qualified to fulfil the object here contemplated. By employing a number of small shallow vessels, such as saucers, of white ware, containing a graduated series of permanganate solutions of various determined strengths, and leaving them exposed during the requisite period of time, a tolerably fair estimate may be formed of the average state of the air. Place in line, four or a larger number of perfectly clean small dishes of white earthenware. Into each pour one

ounce of distilled water.* To the first, then add a single drop of a solution of pure permanganate of definite strength, such as Condy's Patent Ozonised Water;† to the second, add two drops; to the third, three drops; to the fourth, four; and so on to the last, according to the number of vessels used. Let the dishes so charged, remain over night or during any period of the day, exposed to the air in a quiet corner of the room where the experiment is to be made. On examining them in the morning or at the end of the period determined on, it will be easy to judge comparatively of the condition in which the atmosphere has been maintained during the time of their exposure. If the solution in No. 1 only has entirely lost its pink colour, the air has been of normal purity; should No. 2 be completely decolorized, the air must have been loaded with twice as great an amount of impurity; the total decoloration of No. 3 will indicate the presence of a three-fold quantity of impure matter; the loss of all pink colour in No. 4, or the stronger solutions, will demonstrate degrees of impurity verging more or less on positive pollution. Although the results obtained in this way may not be admissible as data for philosophical purposes, they are sufficiently accurate for ordinary sanitary objects. By practice, this simple method is capable, in the hands of any person of common intelligence, of rendering important service in the management of the sick room, since, by its means, the occurrence of even a temporary undue accumulation of foul air, can be rendered apparent. When applied as a sanitary tell-tale, in the wards of an hospital for instance, the vessels containing the solutions would

* As distilled water is rarely free from organic matter, it will in general be better to employ water which has been purified by standing in contact with a quantity of permanganate, just sufficient to tinge it at first of a delicate pink hue, till all colour has disappeared.

† When this is not at hand, Condy's Disinfecting Fluid, reduced by the addition of two parts of water, may be used instead.

of course require to be enclosed with wire work under lock and key, to prevent tampering.*

Although the application of the alkaline permanganates to the testing of the atmosphere is but in its infancy, and leaves room for improvement as regards the mechanical appliances which are necessary for very accurate results, the scientific principle on which it is based, is as certain and reliable as any chemical reaction We expose to the air in two different localities of similar temperature, an equal portion of the same aqueous solution of permanganate of potash, in vessels in every respect alike, and find that in one of them the distinctive colour of the permanganate fades and disappears twice as rapidly as in the other. In order to make sure that the cause does not lie in the vessels but in the medium surrounding them, we change the one for the other and repeat the experiment with fresh quantities of solution of the same strength. Again, the progress of decoloration is twice as rapid in one place as in the other. The loss of colour could only be occasioned by decomposition of the permanganate, and decomposition could be produced by no other cause than contact with a decomposing agent. There was nothing in contact with the solution in either place, except the vessel containing it and the air. But as the greater rapidity of decomposition which was observed in one of the localities, took place alike with both vessels, it could only be the result of different conditions of the air, and the presence of a larger amount of oxidizable matter in one atmosphere than in the other, must have been the circumstance which constituted that condition. We have seen that of the foreign matters with which the air is liable to be contaminated, there are very few indeed which are not of an oxidizable nature: it is therefore but reasonable to infer that the decomposition produced in the permanganate solution was caused by atmospheric impurities, and

* Mr. E. G. Wood of 74, Cheapside, has for sale, under the name of "Condy's Tell-tale Air Test," a box containing everything requisite for this use of the permanganates.

that the rapidity with which it proceeded, would truly indicate the comparative amount, or the comparative oxidability of such impurities.

Great rapidity of decomposition might be caused by the presence of comparatively small quantities of sulphurous acid,* carbide of hydrogen (olefiant gas), or sulphuretted hydrogen, which have a very powerful action on the permanganates, or by a larger proportion of some less active impurity, such as common dust. Although a very large amount of the latter material might be productive, in a given time, of as great change in the permanganate solution as a much smaller quantity of some more active body, it is nevertheless certain that the rate of decomposition is in general determined by the greater or less oxidability of the substances with which it comes in contact. This is of great practical importance since the ordinary forms of organic matter are oxidizable precisely in proportion to the progress they may have made towards decomposition. We are consequently bound to suppose, for instance, that those nitrogenized compounds which are found in the moisture exhaled from the human body, are capable of exerting their action on the permanganate,

* This gas, which always prevails in the atmosphere of towns where coal is largely consumed, as acetic acid does in places where wood is the fuel in use, can hardly be regarded as a noxious impurity any more than the nitric acid, which occurs in the air of the country, can be ranked as such. The two former acids, in some circumstances, act the part of preventives against marsh miasms, which have often been observed to be incapable of penetrating into towns, even when surrounded by malarious districts infested with remittent and intermittent fevers. Acetic acid, having no action on the permanganates, cannot constitute a source of error in observations made with the air test, but sulphurous acid is calculated to lead to erroneous estimates of the character of the atmosphere of coal-burning towns in regard to its wholesomeness. The error caused in ozonometrical observations by the presence of nitric acid is of a somewhat similar nature, with this difference in its favour, that nitric acid being itself an ozone product is not antagonistic in its hygienic properties to that substance, whereas sulphurous acid, when not in excess, is of an opposite sanitary tendency to deleterious organic impurities, which are the matters the air test is intended to reveal.

according to the condition of instability or permanence in which they may at the time happen to be. When uninfluenced by any cause tending to their transformation, they act feebly; when in a state of decomposition or influenced by causes which promote metamorphosis, they must be more prone to form combinations with oxygen.

Now this is precisely what all the best authorities conceive to be the intimate nature and condition of those emanations from the bodies and intestinal discharges of persons suffering from contagious diseases, to which the term *materies morbi* has long been applied, whose only ascertained property is that of generating in other individuals, predisposed for their development, definite affections, in the course of which matter possessing the same power is reproduced. There is no evidence to show that these substances are of a gaseous or even truly vaporous nature. The fact that those contagious matters which are accessible, such as the virus of cow-pox and of syphilis, may be dried in the air without exhibiting any signs of volatility, tends to the contrary conclusion. If the matters of contagious diseases were of a volatile nature, they would evidently by the law of gaseous diffusion, be liable to pervade the entire mass of the atmosphere in a form of extreme attenuation not at all admissible from what we know of their effects. Volatility, moreover, which implies simplicity of constitution and a limited number of atoms in the integrant particles of matter, would be incompatible with the organic character of such substances. We know that mere gases of the kind principally exhaled from persons suffering from fevers and other similar contagious affections, as ammonia, sulphide of ammonium and such like, are of themselves insufficient to cause special disease when breathed admixed with air. But as the vapours of volatile liquids carry with them sensible quantities of all the solids which are held in solution by them, the gases and exhalations given off from fever patients and their excretions, are well suited for

becoming the vehicles of non-volatile contagious matters, in the shape of consistent particles of complex matter analogous to the polybasic combinations of the organic kingdoms.* Being derived from the blood, these bodies may be presumed to exist in a peculiar state of active transformation, capable of communicating itself to the circulating fluid of other individuals of the same species, when so circumstanced as to be unable to conduct their metamorphosis into simpler and more permanent forms. As they are clearly susceptible of increasing in activity and of propagating their condition, according to the circumstances in which they may be placed, they must also be capable of diminishing in morbid force, and of suffering resolution into a state of inertia by conversion into the last products of transformation. The progress of such matters will be regulated entirely by the opportunities afforded them of meeting with active oxygen, which, whether in the process of combustion continually kept up within the body by the respired air, or in that which is as unceasingly in operation without, is the great means employed by nature for the extinction of abnormal influences and the maintenance of sound sanitary conditions in the organic creation.

If they do not consist merely of the usual organic substances contained in bodily exhalations, brought into a peculiar catalytic state, these morbific matters at all events cannot be supposed to differ in constitution, in any material respect, from ordinary animal bodies. They are probably complex organic products possessing a quaternary arrangement of elements, like the generality of animal matters. Their morbid power resides in their peculiar dynamic condition, which is capable of maintaining itself so long as no elementary change occurs to alter their state. In this respect these substances, in their intimate nature, may justly be compared with those poisonous

* Graham's Elements of Chemistry, p. 282 (1842).

products which, under certain circumstances, are developed in some kinds of sausages, and occasionally in the human body after death. As it has been found impossible to extract any special virus from such putrid substances, so it is easy to understand why we are unable to recognise any tangibly poisonous material in the emanations of persons struck down by contagious diseases. In both cases every known method of investigation has failed to reveal any peculiar morbid compound, and the presence of the morbific force is only rendered cognisable to the senses by the train of symptoms excited in the system of those brought within its influence, which will be more or less felt according to the greater or less degree of intensity of the state of metamorphosis in which the poison happens to be at the moment of its reception, the nature of the medium through which it finds admission to the living body, and the presence in the system of materials capable of entering into the same state.* The facility with which those matters communicate their peculiar condition to the blood of individuals predisposed to receive such impressions, may be easily comprehended by calling to mind the extremely complex nature of the circulating fluid, its constant state of transformation, the manner in which it is dispersed throughout the entire body and permeates every tissue from the lungs and bowels within to the skin without, and above all the circumstance that such morbific matters are themselves blood products, and consequently composed of constituents most favourably circumstanced for the diffusion of their peculiar state of mobility in the circulating mass.

It is a law of catalytic metamorphosis, that a body in the act of decomposing, on being added to a fluid in which its own constitutents are present, is itself reproduced, exactly as new yeast is formed by the addition of that substance to saccharine liquids containing gluten,

* Dr. Budd, of Clifton, on the Propagation of Typhoid Fever; *Lancet*, Dec. 12, 1856.

and that the only limits to this process of reproduction are the amount of matter present which is capable of undergoing such alteration, or the supervention of some counteracting influence. This change takes place with more certainty when the fluid acted upon contains among its constituents the substance from whose transformation the body suffering decomposition was formed.* We have a familiar instance of the action in question in the "turning" of milk, when placed in dishes not scrupulously clean, and to which some particles of older milk in a sour state have been allowed to adhere, or when intentionally soured, as in the preparing of the *yaourt* of the Turks and other pastoral people, by the addition of a reserved leaven of coagulum. Although milk is a homogeneous fluid in a state of quiescence, as compared with the warm blood of the body, which, to use the beautifully comprehensive expression of Liebig, is "the sum of all the organs and tissues in the act of formation," the extreme sensitiveness it displays to fermentive influences, affords an instructive subject for reflection.

Of the oxidizable impurities which are found in the atmosphere, few are so disposed to combine with active oxygen as the decomposing effluvia which proceed from the morbid and putrefying bodies, and the effete excreta, of men and other animals. When in a condition for combination, their elements form with that substance compounds of a most permanent nature. Assuming those matters to resemble in constitution nitrogenized animal bodies, their behaviour in the presence of permanganate of potash may be represented by the following equation:

$$\underset{\text{animal effluvia.}}{H\,O_4C_7N_2} + \underset{\text{permanganate of potash.}}{7(Mn_2O_7+KO)} =$$

$$\underset{\text{water.}}{HO} + \underset{\text{carbonic acid.}}{7CO_2} + \underset{\text{nitric acid.}}{2NO_5} + \underset{\text{binoxide of manganese.}}{14MnO_2} + \underset{\text{potash.}}{7KO}$$

* Liebig's Chemistry of Agriculture, by Playfair, 4th ed., p. 382.

Every particle of such substances which thus undergoes oxidation, represents so much unwholesome matter reduced to an inert and innoxious condition, and the quantity of permanganate decomposed will correspond exactly to the amount of impurities destroyed. Were it possible to bring the organic matter, as it exists for instance in offensive exhalations, into rapid and intimate contact with the permanganate, the process of purification would be instantaneous and complete. This, however, is perhaps scarcely attainable. The destruction and withdrawal of such impurities as obtain contact, must, nevertheless, have the effect of lessening the total amount present, and of improving the average purity of the air operated on. In the atmosphere of confined spaces, or of places where the source of impurity is limited, as in a room containing but one or few cases of some contagious disease, this result is speedily obtained. The mere exposure of an extended surface of permanganate solution, will in general suffice to destroy as great an amount of impurity as that which is continually being imparted to the atmosphere.*

To render complete the effects produced, some means are wanted of increasing the degree of contact between the purifying agent and the polluted air. For this object various contrivances have been employed, such as cloths or mats extended in the air and kept moistened with the permanganate solution, and fountains throwing up jets of water impregnated with this substance. The most perfect contrivance of this kind, is perhaps that invented by Mr. J. White, Surgeon, of Finchley, for the purification of the air by water alone. The results obtained by him from the use of his machines in ventilation are extremely interesting, and fully prove how much the air can be improved by mere mechanical washing. That something

* The purifying effects produced on foul atmospheres by the exposure of large surfaces of permanganate solutions, can readily be ascertained by comparative observations, with Smith's on Condy's air test, made before and after exposing the solutions.

more active than water is required to neutralize the foul exhalations and miasmatic emanations, which are the sources of the most dangerous atmospheric impurities, is however admitted by that gentleman. For cases in which there is a marked excess of impurity, he recommends the addition of Condy's Disinfecting Fluid to the water with which he operates. It would seem to me to be safer and more in conformity with our knowledge of the subject, in no instance to dispense with that substance, which is confessed to be indispensable when purification is of most importance. In the natural purification of the atmosphere there is no variation of means according to the intensity of the impurities to be overcome: one uniform and simple but perfect process, meets every case. The transformation of atmospheric oxygen into ozone, by means of natural electrical currents, is nature's sole system of purification. If the production of ozonic oxygen in the state in which it exists in the atmosphere cannot at present be considered attainable, except to a very limited extent, we at all events have in the salts of permanganic acid, which Schönbein has shown to be a true ozonide, substances capable in a very great measure of acting a similar part in the limited operations of purification, to which we may require to have recourse. While nature has at command an unbounded supply of atmospheric ozone with which to maintain the purity of the earth and of the air we breathe, we, in the permanganates, possess a group of bodies that put within our reach, in a condensed form, available for use at any given time or place, oxygen in the nascent state, which, though artificially produced, is in fact that very purifying agent of nature—*ozone* itself.

In the present comparatively advanced state of knowledge on sanitary subjects, it would be superfluous to insist at much length on the bad effects of contaminated air on the health of those exposed to its influence. Air loaded with the products of respiration or other foul matters, is as unfit for breathing, as dust is for food; its

chemical capacity is gone, its affinities have produced their effect. Indeed, it is far worse. Dust would but cheat the stomach, affording no pabulum for blood, but leaving unhindered in its changes whatever of wholesome food there might remain in it. Impure air, as such, not only contributes nothing to the life of the body, but robs it of what life it has, and directly impedes the changes which it should sustain.* All the zymotic diseases, and a very great number of those constitutional affections which occupy so prominent a place in the returns of the Registrar-General, may be said to have their principal cause in the impurity of the air of human habitations, resulting from defective ventilation and its usual accompaniment, general uncleanness. The injurious nature of polluted air is very distinctly shown, by the directly poisonous effects which are produced on wounds, by exposure to contaminating atmospherical influences, and by the way in which puerperal fever, hospital gangrene, and erysipelas are propagated. An instructive but lamentable illustration of such baneful effects, is furnished by the excessive rates of mortality found to prevail in the overcrowded and foul wards of certain hospitals. Some substantial pollution, liquid or solid, is always connected with the origin of every atmospheric contamination. The combustion of solid substances, the decomposition and disintegration of organized matter, the respiration of animals and plants, or those peculiar morbid conditions of them which constitute disease, are the chief sources of aërial impurities. It is, perhaps, impossible to conceive of any atmospheric taint which has not at first proceeded from fixed matter. A fever-struck patient, or a certain amount of concentrated human foulness, is necessary to the production of the poison which occasions typhoid fever, just as those foul conditions of the atmosphere which, in surgical practice, are productive of fatal results, require

* On Health; *Cornhill Magazine*, vol. iii, p. 337.

the presence of some focus of material taint for their development. It must therefore, in most cases, be productive of but partial advantage to undertake the purification of the air, without, at the same time, adopting effectual measures for maintaining domestic, clinical, and personal purity.

Under ordinary circumstances, free ventilation with pure air, and washing with water in conjunction with some detergent body, will suffice for that object. Soap is the substance which is universally relied on, and when accompanied with a due amount of friction, it is undoubtedly the most generally useful detergent hitherto known. Unfortunately, however, it is far from possessing all the qualities required in a true purifying agent. To a certain extent, soap is a solvent of ordinary dirt, which usually presents itself in the form of a more or less greasy compound. But it is without power to neutralize and destroy impure organic matter. On the contrary, being itself composed of an alkaline base in combination with a fatty organic acid, which a great variety of substances cause to be separated, washing with soap alone not unfrequently leaves behind almost as great an amount of organic matter as was present before its application. Indeed, in many cases, if used with little or no friction, it may be said to be useless. This is strikingly the case in personal ablutions. Soap is, no doubt, extremely useful for washing the hands, which are peculiarly exposed to contract extraneous dirt, but for cleansing other parts of the body it is of comparatively little value. Since the introduction into this country of Turkish baths, this fact has been practically experienced by so large a number of persons, as to be now undeniable. Everyone who has been duly steamed and rubbed in one of those establishments, must have been forcibly impressed with the total inefficacy of mere washing with soap and water to remove the greasy incrustations of the body. Instead of diminishing the amount of organic matter adherent to the skin, the

use of soap in personal ablution must in many cases really add to it, since the secretions being often of an acid character, unite with the alkaline base of the soap, and set free its oily acid, which then adheres to the surface of the body, and forms a kind of varnish which no mere towel rubbing can easily remove. This takes place in a remarkable degree when some coarse varieties of soap are used. The greasy deposit left by such soaps, derived as it is from the impure and offensive fats and oils usually employed in soap-making is not calculated to promote cleanliness and health. Not even the purest and best soaps can possibly leave a deposit in any way to be regarded, in a sanitary point of view, as an advantageous application to the skin. Other familiar instances exemplifying the absence in soap of properties suited to destroy organic impurities, only require naming, in order to be recognized and admitted, such as the disagreeable odour often present in clothes just received from the wash, as well as in tubs and other utensils used in washing clothes when not well scrubbed, and that most nauseous stench which is given off from sinks and drains where soaps-suds are liable to accumulate and decompose.

It is a circumstance greatly in favour of the familiar use of the alkaline permanganates for the purification of air, that the chemical composition of those salts, by qualifying them to neutralize organic impurities in whatever form they occur, renders them in a remarkable manner fitted for affording topical protection against the septic influences of foul air, as well as for most of the purposes of domestic, and bodily ablution. Though not calculated to take the place of soap, they will be found extremely useful as supplementary detergents to that familiar article, as well as in a great variety of cases in which soap is not qualified to produce the desired results. More or less diluted with water, the alkaline permanganates furnish the most efficient means of purifying household utensils of all kinds, and of removing

from them every vestige of taint and odour. Being entirely without noxious effects on the human frame, they are equally well adapted for the purification of the person. Used in the ordinary ablutions, and in the bath and bidet, these highly ozonised substances add greatly to the cleansing effects of water, and thus promote purity, healthy freshness, and vigour of body. While, therefore, the alkaline permanganates, on the one hand, are capable of securing the purification of the air from those unwholesome contaminations which endanger health, on the other, they are, by reason of their remarkable disinfecting properties, admirably qualified for restraining and counteracting all those foul and morbid conditions of organized bodies in which aërial impurities have their origin.

WATER:

ITS IMPURITIES AND PURIFICATION.

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Few facts in sanitary science are better established than the injurious effects which are produced on the health by impure water, when used for dietary purposes. Numerous observations made by the Metropolitan Medical Officers of Health, and other competent authorities, have placed this beyond doubt. In his work on "Drainage and Water Supply in connection with Public Health," Dr. Snow brought out very clearly the great influence of foul water on the prevalence and mortality of cholera. The reports of Mr. Simon lead to the conclusion that during past epidemics of that disease, the population using water in which a large per centage of organic matter could be detected, suffered more than three times as much as the population drinking purer water. Dr. Budd, of Clifton, has proved water to be one of the vehicles by which the infectious matter of yellow and other malignant fevers is sometimes communicated. It was distinctly shown by Dr. Lankester that the outbreak of cholera which occurred in 1854, in Brewer Street, and the surrounding district, was connected with the impure state of the water of a pump in Broad Street, Golden Square, from which many of the inhabitants were in the habit of drawing their supplies. Dr. R. D. Thomson has on many occasions demonstrated the baneful effects of water impregnated with organic matter in inducing cholera; and more particularly in 1854, in respect to the Soho supply of the New River Company, into which, for a time, the contents of an impure well were introduced, and in 1857, to the water of a pump at West Ham, which

was proved to have acted almost with the virulence of a poison. Similar observations were made in 1852 at Exeter, in 1853 at Newcastle-on-Tyne, and in 1854 at Hull. In the latter year the much greater liability to, and mortality from, cholera, that was noticed to exist among that portion of the population of Lambeth which was supplied with water by the Vauxhall Company, taken from the river at Battersea, compared with what prevailed among other portions of the same population, even in the same street, whose water supplies were drawn from the Lambeth Company's Works, situated higher up the stream at Thames Ditton, afforded an instructive instance of the baneful influence of an undue proportion of organic impurities. Since then numerous other opportunities have been afforded of tracing the deleterious effects of tainted water on the health of those using it. During the summer of 1861, the unfavourable state of the health of Norwich having caused attention to be directed to the character of the water supplied to that town, Mr. F. Sutton, by careful and repeated analysis, found that none of it contained less than nine grains of organic matter per gallon, while the greater portion, furnished by the Norwich Water Company, was polluted with as much as 22·22 grains of inorganic impurities, and 16·05 grains of matter of organic origin per gallon. Somewhat later a similar condition of the water supplies, combined with dirt and bad ventilation, produced at Over Darwen an outbreak of gastric and typhus fever, which was officially investigated and reported upon by Dr. H. Greenhow. Still more recently the opponents of sanitary reform in Canterbury have been obliged to admit, that the high rate of mortality observed in some of the quarters of that town "is caused by overcrowded dwellings, filthy habits, poverty, intemperance, *and above all a want of wholesome water.*" The records of adventurous travel, military expeditions, and naval explorations, afford abundant examples of the mortality which is occasionally entailed by the use of polluted water.

All kinds of impurities or foreign matters, whether organic or inorganic, to which water is subject, may justly be regarded as injurious to heath; but it is especially the former class of substances which, on meeting with unwholesome atmospheric or other influences, give rise to those sudden visitations of disease, which under the forms of intestinal fevers, cholera, &c., carry off so many victims. Some inorganic impurities in the long-run undoubtedly prove prejudicial to health, but they seem to be incapable of producing the serious symptons which characterize zymotic diseases. To defects in the composition of water, as regards its inorganic constituents, have been ascribed various chronic and constitutional affections, of which the "Aleppo button" and goître are two of the most remarkable examples. Such evil effects are, however, slow and insidious compared with those caused by organic contaminations, which, under certain circumstances, act very much like poisons, or those emanations from organized beings on which contagion depends. Like the latter, whose morbid influence Liebig has so clearly shown to be the result of a certain state of transformation, which acts on the blood—itself an extremely complex compound, in a condition of constant metamorphosis—after the manner of a ferment, organic impurities must be regarded rather as exerting a certain amount of morbific force, than as constituting a given volume of positively deleterious matter. Hence, extremely minute quantities taken into the system are capable of producing very extensive mischief.

The most dangerous kinds of impurities, then, are those of organic origin. They occur either in a state of solution or in the solid form. The former being invisible even with the aid of the microscope are the most to be feared, especially as they are generally accompanied by the presence of carbonic acid and alkaline nitrates, the results of decomposition, which, by communicating a sparkling appearance and cooling taste, render those waters which contain them deceptively agreeable to the palate.

The detection of organic matter in water had long presented serious difficulties to chemists, who were obliged to have recourse to very tedious methods, based on the estimation of the amount of nitrogen and carbon contained in the deposit formed by the evaporation of the water submitted to examination. Having for many years been in the habit of using the alkaline permanganates for the removal of organic impurities from certain liquid substances, which, as a manufacturing chemist, I was engaged in making, I had my attention early directed to the part which those salts were capable of performing in the purification of water. After satisfying myself that the action of those substances could with certainty be relied on for the detection and practical estimation of varying quantities of organic matter, in the year 1856, I communicated my method to several of our leading chemists, and, among others, to Professor Hofmann and Dr. R. D. Thomson, who verified my experiments and reported favourably of the advantages of my method.* In 1858, when the offensive state of the Thames gave rise to so much complaint and speculation, I repeatedly demonstrated the efficacy and simplicity of the permanganate tests before the representatives of the London press. Since then, my plan has been very generally adopted among analytical chemists as the readiest and most reliable means of detecting organic matter in water, and of determining the relative purity of different samples. Its superiority has been recognized by the scientific authorities of the Government department of science and art, and the application of the alkaline permanganates to the testing of water, specially pointed out in

* I have been informed that Professor Forchhammer, the Danish chemist, some eight or ten years ago, in a paper read before the Royal Society of Sciences of Copenhagen, when alluding to the action of organic matter on permanganate of potash, suggested the advantage that might be taken of this circumstance for the detection of soluble organic impurities in water. The paper in question does not, however, appear to have been noticed in any British publication; nor does it seem to have made allusion to the *purification* of water by means of the alkaline permanganates.

the printed papers for popular instruction at the South Kensington Museum. "The microscope," says Dr. Lankester, in a lecture on water, delivered at that institution in May, 1859, "can alone fully exhibite the nature of organic impurities suspended in water, but the application of Condy's Fluid, which is a solution of permanganate of soda or potash, supplies a ready means of chemically indicating the relative organic impurity of water. From the time I first witnessed this property of the permanganate I have employed it to test the relative purity of waters, and have found it of the greatest value."

The efficacy of the permanganates as tests for water has since been confirmed and ably illustrated by Monsieur Emile Monnier.* This gentleman found that the action of permanganate of potash on organic matter in water, which at ordinary temperatures proceeds very slowly at degress of heat varying from 70° to 75° C. (158° to 186° Fah.) takes place with great rapidity. By operating on equal volumes of various samples of water at a fixed temperature, he was enabled with great accuracy to demonstrate the comparative impurity of each by the quantity of permanganate of potash decomposed. Applied in this way, the permanganate test distinctly established the fact, that the waters of the Bièvre contain nearly ten times as much organic matter as those of the Seine at Bercy, since, while a litre of the latter only decomposed 6 milligrammes of permanganate, the same volume of the former decomposed 58 milligrammes.

But the action of the permanganates is not limited merely to the testing of water for organic impurities; the properties possessed by those substances, of rapidly decomposing organic matter, and making manifest to the eye their effects, render them admirably suited to the *purification of water* employed for drinking, cooking, and

* Détermination des matières organiques des eaux, par M. Em. Monnier; *Comptes Rendus de l' Academie des Sciences*, vol. l, p. 1084. June 11, 1860.

general domestic purposes. Composed of oxygen in combination, with maganese, the mildest and most wholesome of the metals, and one or other of the alkalies, the alkaline permanganates can hardly be supposed capable of proving injurious even when, from haste or carelessness, a trace of them in solution or a minute portion of binoxide of manganese in suspension may remain in the water treated: for it has recently been shown that manganese is one of the normal constituents of the blood, and that in some of the very healthiest races of men, such as the Scotch, who are fed to a great extent on oats, a cereal which contains that metal, it is always present in the body. Indeed, it is extremely probable that manganese is a requisite constituent of the human frame, and that its entire absence is not conducive to health. The nature of the reaction which takes place between those compounds and organic matter is, moreover, such, that when they are used with caution, and not in excess, the whole of the metalic ingredient present is separated by precipitation in the solid form, leaving in the water only the alkali which had been in combination with it. As most waters, by reason of a certain portion of carbonic acid which they contain, hold in solution, in the form of bicarbonate, a small quantity of carbonate of lime, the presence of this free alkali is rather an advantage than the contrary, since by neutralizing the excess of carbonic acid it converts the more soluble bicarbonate into a less soluble carbonate, which then subsides as a deposit, leaving an alkaline carbonate in its place, thus:—

$$\underbrace{KO,Mn_2O_7}_{\text{permanganate of potash.}} + \underbrace{3HS}_{\text{hydro-sulphuric acid from organic matter.}} + \underbrace{CaO\ 2CO_2}_{\text{bicarbonate of lime.}} =$$

$$\underbrace{2(Mn,O_2)}_{\text{binoxide of manganese.}} + \underbrace{3S}_{\text{sulphur}} + \underbrace{CaO,CO_2}_{\text{carbonate of lime.}} + \underbrace{3HO}_{\text{water.}} + \underbrace{KO,CO_2}_{\text{carbonate of potash.}}$$

Or where hydrosulphuret of ammonia from decomposing organic matter is also present with hydrosulphuric acid and bicarbonate of lime, carbonate of ammonia will be left in solution, together with the other alkaline carbonate, thus:—

$$\underbrace{2(NaO, Mn_2O_7)}_{\text{permanganate of soda.}} + \underbrace{3HS}_{\text{hydrosulph. acid.}} + \underbrace{3(NH_3\,HS)}_{\text{hydrosulphuret of ammonia.}} + \underbrace{5(CaO\,2CO_2)}_{\text{bicarbonate of lime.}} =$$

$$\underbrace{4(MnO_2)}_{\text{binoxide of manganese.}} + \underbrace{6S}_{\text{sulphur.}} + \underbrace{5(CaO, CO_2)}_{\text{carbonate of lime.}} + \underbrace{6HO}_{\text{water.}} +$$

$$\underbrace{2(NaO, CO_2)}_{\text{carbonate of soda.}} + \underbrace{3(NH_3CO_2)}_{\text{carbonate of ammonia.}}$$

In certain special cases where the presence of alkaline matter might be objectionable, permanganate of lime may with much advantage be employed instead of the true alkaline permanganates. When this salt is used, the lime which constitutes its base, is converted into carbonate by union with the carbonic acid held in solution by the water, and precipitated along with binoxide of manganese and sulphur. There then remains a fluid of very remarkable purity, which, so far as organic matters are concerned, surpasses even ordinary distilled water, which is seldom entirely free from impurities of an organic nature. This reaction may be thus formulated:

$$\underbrace{CaO, Mn_2O_7}_{\text{permanganate of lime.}} + \underbrace{3HS}_{\text{hydrosulph. acid.}} + \underbrace{CaO\,2CO_2}_{\text{bicarbonate of lime.}} =$$

$$\underbrace{2(MnO_2)}_{\text{binoxide of manganese.}} + \underbrace{3S}_{\text{sulphur.}} + \underbrace{2(CaO,CO_2)}_{\text{carbonate of lime.}} + \underbrace{3HO}_{\text{water.}}$$

Nor is this all, for the oxidizing properties which enable the permanganates to consume organic impurities, give

them the power of removing from water, when held in solution by it, those metals which are susceptible of being converted into peroxides, as is clearly demonstrated by the following experiment.

By shaking common white lead in distilled water and filtering, I made a saturated solution of oxide of lead, which, on being tested with hydrosulphuric acid, showed a black precipitate. I took four ounces of this solution and added to it two drops of a solution, consisting of two grains of permanganate of lime dissolved in one ounce of distilled water. This mixture I found did not immediately lose the pink colour communicated by the permanganate. I let it stand half an hour, by which time all shade of pink had disappeared, and was replaced by a brown colour (that of binoxide of manganese), which proved that the expected reaction had occurred. I then filtered it through filtering paper. The filtrate was colourless, but on being tested afresh with hydrosulphuric acid, it again acquired a dark tint, much less, however, than in the first instance. This was a sign that lead was still present, though in a minor degree. I recommenced with the same quantity of the solution of oxide of lead, but this time added five drops instead of two of the solution of permanganate of lime. The colour imparted was pink, somewhat deeper than in the former case. To hasten the reaction with a view to save time, I heated half an ounce of the pink solution in a test tube and filtered. The filtrate showed not a trace of lead on the application of hydrosulphuric acid. Without using heat, I allowed the remainder of the mixture to stand two hours. When then examined, the colour was found entirely changed from pink to brown. A portion of this was tested as before for lead; the result indicated its entire absence. The rest was set aside without being filtered till the following day: the binoxide of manganese formed by the action of the permanganic acid had entirely subsided, carrying with it the peroxide of lead, and leaving the

water clear and free from trace of that metal. The following is the rationale of this reaction—

$$\underset{\text{permanganate of lime.}}{CaO, Mn_2O_7} + \underset{\text{protoxide of lead.}}{3PbO} = \underset{\text{binoxide of manganese.}}{2MnO_2} + \underset{\text{peroxide of lead.}}{3PbO_2} + \underset{\text{lime.}}{CaO}$$

The permanganic acid of one equivalent of permanganate of lime converts three equivalents of protoxide of lead into peroxide, and resolves itself into two equivalents of binoxide of manganese, all of which, from being in a state of solution, become insoluble, and are precipitated. Water can thus be readily and completely freed from lead, which is the most poisonous of ordinary metallic contaminations, and by reactions of a similar nature from all metals capable of assuming the form of peroxides.

It is evident that by the same means water containing ferruginous impurities, may be purified so as to render it fit for use in dyeing and other industrial and economic processes. The avidity which iron exhibits for oxygen, makes this reaction absolutely certain. The same thing holds with regard to copper, which, though rarely met with as an impurity in water, is not less injurious in its effects than lead. It may here not be out of place to observe, that these reactions point out the utility of the alkaline permanganates, as antidotes in cases of poisoning by any of the above substances.

Of all the methods of purifying water which have hitherto been in use, there is not one that, even under the most favourable circumstances, with space and time at command, can be considered of much efficacy. Ordinary filters remove suspended impurities only; ebullition destroys the vitality of animal and vegetable impurities, and separates carbonate of lime; the action of alum, so far as organic impurities are concerned, is more of the nature of a mere clarifying agent than that of a chemical purifier of water, in which it necessarily leaves an admixture of styptic

matter, with a salt of potash or ammonia, and substitutes sulphate for bicarbonate of lime; caustic alkalies do nothing more than throw down carbonate of lime, leaving alkaline carbonates in its place; alkaline carbonates soften water by decomposing earthy salts and precipitating earthy matters; like ebullition, caustic lime merely separates carbonate of lime; while even distillation itself, as ordinarily conducted, leaves water which previously contained organic matter contaminated to a certain extent with that impurity, and deprived of the oxygen which is necessary to render it palatable and wholesome.

Filtration through charcoal or bone-black has no doubt considerable effect in absorbing certain gases, which are products of the decomposition of organic matter; but it acts only very partially on such matter when not in a decomposing state. Hence water, which has been more or less deodorized by means of charcoal, will often be found, on being allowed to stand, to become again offensive, from the further decomposition of organic matter, which the charcoal had been adequate to remove. The presence of such organic impurities in water which has been treated by charcoal, can always be readily detected by means of the permanganates. Nothing proves so distinctly the superiority of those substances for purifying water as the certain and delicate way in which they discover the imperfections of all other methods of purification, whereas no substance that I am acquainted with is capable of revealing the presence of organic matter after their use as purifiers. The permanganates then not only afford a ready and efficacious means of doing what charcoal is supposed, in a tedious and imperfect manner, to perform, but likewise of producing changes similar to those effected by most of the other modes of purification which are usually recommended or occasionally practised, especially when, as in the crude state, they are combined with considerable quantities of caustic alkali. In that form they do all that alum, alkaline carbonates, and

caustic lime are capable of accomplishing, while they even surpass ebullition and distillation in their power of removing organic matter, at the same time that, by the formation and precipitation of oxide of manganese which take place at all points of the water during their contact with substances of an organic origin, they have the effect of mechanically drawing down impurities held in suspension. Water, therefore, which has been purified by the permanganates, is, in most instances, pure enough for every ordinary purpose, and so charged, moreover, with oxygen as to be highly agreeable to the palate, and beneficial to digestion. When absolutely pure water is required for some special scientific object, as photography for instance, it can be readily procured by one distillation with an alkaline permanganate.

Although the purification of water, by means of the permanganates, has not, so far as I know, been yet applied on any very large scale, it has been sufficiently tested on board the vessels chartered by the Government Emigration Board, to place, beyond doubt, the practical value of this method. Inserted in the Charter Party of the Emigration Commissioners, as a necessary sanitary article, Condy's Fluid, which is a preparation of alkaline permanganates, has been found peculiarly useful in purifying the water on board their ships,—an object which all naval surgeons agree in considering of the utmost importance in a hygienic point of view. The badness of the water usually stored on board ship is but too commonly made an excuse for frequent indulgence in spirits. "As the sailor is at present situated," says Dr. J. D. Hooker, in a communication on this subject, addressed to Mr. Spencer Wells, "there is no available substitute for bad water but grog." Even the distilled water, produced by the apparatuses of De Normandy and others, is not of a quality to render it very tempting as a beverage. Like most water only once distilled, it generally contains a certain per-centage of organic matter, accompanied by marked

vapidity of taste, which strongly invites the addition of rum. This vapid flavour is rapidly and completely removed by the oxygenating action of the permanganates. After a little experience of their effects on water, sailors would soon come to appreciate the purifying properties of those substances, since they would find that by their use water, whether drawn from a putrid cask, or from an unwholesome stream, marsh, or other source, is, in the course of a very short time, rendered both pure and palatable.

Benefits similar to those which have been experienced from the use of Condy's Fluid, as a purifying agent for water, on board ship, would be derived from its application to the tank-water of warm climates, which, in general, consists of collections of rain water. In tropical countries, rain water is much more impure and subject to become offensive, than in cold and temperate ones. This is particularly the case in summer and autumn, or after long continued droughts and very hot weather, and is clearly explainable by the existence of a greater proportion of animal and vegetable substances in the atmosphere in such climates and seasons.

The outbreak of cholera which occurred in 1861 in India, taking place as it did after a drought of long duration, may justly be suspected to have been connected with this, among other causes. It has been stated in the *United Service Gazette,* that the Commission appointed to inquire into the sanitary condition of the troops in India, came to the conclusion that the *exceptional rate of mortality to which the Indian army is subject, chiefly arises from the impurity of the water used by the soldiers.* The inhabitants of most warm climates have no hesitation in ascribing to the use of foul water the origin and prevalence of that very distressing parasite the "Guinea worm" *(Filaria Medinensis),* whose presence in the tissues of the frame disables so many otherwise sound and able-bodied individuals. Indeed, as Dr. R. D. Thomson has

observed in his paper on the "Influence of Impure Water in the production of Disease," which appeared in the London Medical Review for December, 1861, "the inhabitants of India have long connected the occurrence of cholera and other diseases with the use of impure water." In the above paper this gentleman bears witness to the *fatal effects he saw produced among the natives in Bombay, by the use of water taken from the filthy tanks of that town.*

It is with the view of counteracting the baneful tendencies of such waters that the natives of India are in the habit of employing the fruit of the *Strychnos potatorum* under the name of "clearing nut," which seems to exercise a certain effect in improving their quality. Hitherto European science has not been able to suggest any amelioration of native methods beyond the use of charcoal filters, which are too costly and inconvenient for general use. But it is obvious that the alkaline permanganate of Condy's Fluid, would supply exactly the required desideratum of an extremely portable and condensed purifying agent, which could safely be employed by persons of but little skill or experience, and under all circumstances, with the additional advantage that it would also afford a ready counteractive of every morbid and unwholesome influence, by its general disinfecting properties.

The importance of using only soft water in pharmaceutical operations, is admitted on all hands. Medical men, in prescriptions requiring water, uniformly order *aqua pura* or *aqua distillata*. But there is one very important purpose to which water is now very extensively put in surgery, namely, "water dressings," in connection with which sufficient attention is seldom paid to the quality of the water employed. Miss Nightingale, with that practical tact which distinguishes all her observations on hospital economy and the management of the sick, has well pointed out the prejudicial effects produced by the use of impure water for dressing wounds, as compared with those obtained from the application of soft and pure water. "When

water is hard," she remarks in her *Notes on Nursing*, "it is worth while to have distilled water for every water-dressing." There can be no doubt that water charged with mineral and organic impurities, must exert a very deleterious influence on wounds already but too predisposed to unhealthy action. For this and other such purposes, as the warm bath for instance, water purified and oxygenated by means of the permanganates will be found extremely valuable.

The advantages which might be derived from the application of the permanganate process, in many industrial operations, are very evident. In brewing, for instance, there can be no doubt that the presence of putrescible matter in the water used, must often communicate to the beer a tendency to decomposition; just as in Dr. Dauglish's process for making ærated bread without fermentation or chemical re-agents, it has been found by that gentleman that water containing impurities of an organic nature, proves injurious to the quality of the dough. Unlike distillation, which requires an amount of time and fuel in proportion to the scale on which it is carried on, the permanganate process is as expeditious on a large as on a small scale. Indeed, it is even more so; for when large quantities of water are treated, the subsidence of the manganese precipitate is more complete and satisfactory than when small quantities are operated upon. The cost moreover is almost nominal, since the quantity of permanganate necessary to purify 10,000 gallons of potable water, would be contained in one gallon of Condy's Fluid, the retail price of which is but 10*s.*: at this rate 200 gallons or one ton of water, could be purified with an outlay of $2\frac{1}{2}d.$

APPENDIX.

SIMPLE EXPERIMENTS

BY WHICH FAMILIARITY MAY BE READILY ACQUIRED WITH SOME OF THE MORE INTERESTING PROPERTIES OF

THE ALKALINE PERMANGANATES,

(CONDY'S FLUID).

To test water for organic impurities.

TAKE any number of tumblers; fill up one with distilled water, another with ordinary drinking water from a pump, rain water butt, or other supply, and the rest with various samples of water more or less contaminated with organic impurities, such as sewage water. Add to each of them, drop by drop, Condy's Fluid (crimson) till the contents begin to assume a decidedly pink hue. This effect will be produced, in the case of the distilled water, if pure, by a single drop; more will be required by the drinking water, which, after standing a little while, will show some signs of muddiness, and a still larger portion by the other samples, in which a brown precipitate will soon form. The quantity of fluid required and the amount of muddiness produced in each, will be the measure of the relative impurity of the several waters. This experiment may be repeated with other deodorizing fluids, and the results contrasted with those produced by Condy's. By having a separate set of glasses for each of the deodorizers to be tried against one another, the comparison will of course be more conclusive.

To prove the permament nature of the action of Condy's Fluid.

To the above, or other similar samples of water, after treatment with the various deodorizing agents, add a few drops of sulphuric acid; in those in which chloride of zinc or other such deodorizer has been used, any offensive

odour which they previously had will be immediately revived, whereas no such effect will follow on adding the acid to those waters that have been treated with Condy's Fluid.

To purify water on a practical scale.

Pour into a hogshead of offensive drinking water one wine glassful of Condy's Fluid, and mix with a stick or lath. Generally this quantity will render it as sweet as fresh water; should it require more, add half a wine-glassful. So long as organic matter remains, which is known by the pink colour of the fluid gradually vanishing—add the fluid. If a trace too much has been used, continue stirring, or immerse a stick or lath, and the colour will disappear. Let it stand, and any suspended matter present will subside or filter.

The purifying action of Condy's Fluid on water will appear very evident on carefully comparing a sample of common drinking water, after its treatment by the fluid, with another of the same water taken previously to being treated. Filter both through clean blotting paper, and let a person taste them alternately blindfold, or without being aware which of them was the one that had been operated upon. A peculiar purity of taste and smell which characterises the purified water, and can be compared to nothing so well as to the fresh dew of the country, will cause the two samples to be very soon distinguished from each other. In most instances a marked difference of colour will also be perceptible on placing a glass of each on a sheet of white paper, and looking through them upon it: the purified water will generally appear more colourless and brilliant than the other.

To prove the superiority of Condy's Fluid for the purification of water over filtration through charcoal, which is generally considered the best known means of purifying water.

Macerate some hay in a jug of water in a warm place until the contents are charged with vegetable matter: strain and pass through a charcoal filter. Operate on the water so treated with Condy's Fluid, as in the above experiment, when it will be clearly shown that, notwithstanding the use of the charcoal, it still contains a considerable quantity of organic matter.

To demonstrate the innoxious nature of Condy's Fluid as compared with Chloride of Lime.

Take two flower-pots, containing each a plant of mignonette, or other common household flower; water them both during several days, one with water to which Condy's Fluid has been added in the proportion of a teaspoonful to a pint of water, and the other with water into which the same quantity of chloride of lime has been thrown. Examine them from day to day, and in no very long lapse of time the latter will be found drooping or dead, while the former will be as flourishing as ever, or even more vigorous in its growth.

To show the poisonous properties of Chloride of Zinc as compared with those of Condy's Fluid.

Have two ordinary glass fish-globes, each filled with water, and containing some common kind of fish, which can be easily procured; mark one globe B and the other C. At the time when the daily change of water is made, add to the globe B ten drops of Burnett's Fluid for every gallon of water, and to C Condy's Fluid in the same proportion; continue this treatment daily, taking care always to give Burnett to B and Condy to C, till such time as the fish in the former turns on his back, which will very soon be the case. However often this experiment is repeated, and with whatever proportion of fluid, the fish B will uniformly die first, whereas C will in many instances improve in health and condition.

The result will be the same, when, instead of chloride of zinc, other deodorizing agents are tried in this manner against Condy's Fluid; chloride of lime, quicklime, perchloride of iron, tar water, and those numerous antiseptic fluids which were formerly so generally but fallaciously relied on as disinfectants, all exert most injurious effects on animal and vegetable life.

To exhibit the efficacy of Condy's Fluid in removing taint from meat.

Take a small piece of fish, beef, or other flesh, place it on a plate, and covering it over with an inverted tumbler, there leave it. When it has acquired a decided taint, remove it, and after making several incisions, immerse it in a solution of one table-spoonful of Condy's Fluid in a quart of water. Allow it to remain for about ten minutes,

after which it may be removed and washed with pure water, when it will be found to be free from taint.

To demonstrate that the exhalations from the Lungs are loaded with Oxidizable Organic Matters.

Fit a wide-mouthed white glass bottle, with a bung, through which pass two tubes, after the manner of a common sulphuretted hydrogen apparatus, one short and the other long enough to reach inside to the bottom of the vessel. Fill it three-fourths full with pure water, slightly coloured with Condy's Fluid (crimson). To the outside end of the longer glass tube fit a flexible caoutchouc tube, capable of being attached by its free extremity, to the nozzle of a pair of bellows. On blowing air through the water by means of the bellows, if no dust be present, but little or no effect will be produced on the colour of the contents of the bottle; but when the bellows is removed, and the mouth applied, so as to introduce the breath from the lungs, decoloration will soon show itself, after setting the bottle aside for a time.

To detect and purify impure air in rooms, &c.

Add a tea-spoonful of Condy's Fluid (crimson) to a large jug or ewer of water, and empty the contents, in equal portions, into two hand-basins. Place one of these basins in a water-closet, or ill-aired place, and the other in a well-aired hall, or in the open air. After allowing them to remain during several hours, bring them together, and compare the appearances in each. In the former, the water will be found to have lost entirely, or in a great measure, its pink hue, and the surface of the basin in contact with the water, will be covered with a thin coating of brown matter; in the latter, no change, or hardly any, will be remarked. The amount of deposit will be the measure of the impurities taken up and destroyed.

To exhibit the purifying action of Condy's Fluid on foul gases.

Procure a "White's Air Purifying Ventilator," of the several varieties made, choosing the one called the "Water Force Ventilator," which acts by the gravitation of water, and have ready a common sulphuretted hydrogen bottle

charged and in action, into which to enhance the smell may be introduced an admixture of sulphide of ammonium. The apparatus being fixed, shut up one of the two admission pipes, and fill up the reservoir with water, to which has been added Condy's Fluid, in the proportion of two wine-glassfulls to a gallon of water. Turn the tap; the fall of the water will immediately set the fanwheel in motion and cause a current, by drawing in air from below, and discharging it above. Now place the discharge tube of the sulphuretted hydrogen bottle into the open admission pipe of the ventilator, and allow the gas to be drawn into the apparatus.

On applying the nose to the place of exit, a marked difference will be perceived between the odour of the air discharged above and that of the gas coming directly from the bottle, which has a most disgusting smell.

This experiment may be rendered comparative by having two ventilators, in one of which other deodorizers may be tried against Condy's Fluid.

To ozonize air.

Dissolve a wine-glassful of Condy's Fluid (crimson) in a quart of water, add a tea-spoonful of strong sulphuric acid and mix thoroughly. On passing a current of air through this mixture by means of a pair of bellows or some more special contrivance, it will be found to possess the odour and reactions of ozone. By this means the purifying effects of Condy's Fluid, can be directly applied to aëriform disinfection.

To produce permanganic acid in the gaseous state.

Pour a wine-glassful of Condy's Fluid (green) into a cup or jelly pot, which to prevent accidents, place in a basin, and then add all at once a table-spoonful of strong sulphuric acid. There will immediately ascend from the cup containing the mixture beautiful crimson fumes, which are permanganic acid, set free by the violent action of the sulphuric acid on the Fluid.

To use Condy's Fluid as a chloridizer.

Pour a wine-glassful of Condy's Fluid (crimson) into a tea cup, place this on a large plate, and add gradually

a small portion of muriatic acid. Chlorine gas will be instantaneously evolved, and continue to be given off till the permanganate contained in the Fluid or the muriatic acid is exhausted. When the agency of chlorine is required for disinfecting purposes, this is the simplest and most efficacious method of procuring it. The gas thus produced is, moreover, pure fresh-smelling chlorine, and not the nauseous hypochlorous acid of so-called "chloride of lime."

TESTIMONIALS

IN PROOF OF THE VALUE OF THE

ALKALINE PERMANGANATES (CONDY'S FLUID)

FOR THE

PURIFICATION OF AIR AND WATER,

AND

SANITARY OBJECTS IN GENERAL.

St. Thomas's Hospital,
October 31, 1857.

I HAVE carefully examined the disinfecting and deodorizing fluid manufactured by Mr. Condy, and have found it to be most rapid and efficient in its operation. The facility with which oxygen is supplied by this valuable preparation, renders the almost immediate destruction of odours in sewage a matter of certainty. The same instantaneous action is exerted on those smells which frequently increase disease in a household, and which emanate from imperfectly trapped closets and drains. For domestic use it is peculiarly adapted from the absence of any odour in the disinfectant itself, and from facility of its application. I have also found it to have a powerful and rapid influence in the removal of the disgusting odour of putrefying flesh and of tainted meat. *Water of all kinds which has been contaminated with organic matter, and has thus acquired an offensive smell and taste, is immediately deodorized, purified, and preserved by this valuable deodorizer.* I consider it to be a most important addition to sanitary science, and a valuable agent in the hands of the medical profession.

ROBERT DUNDAS THOMSON, M.D., F.R.S.
Lecturer on Chemistry at St. Thomas's Hospital, and Medical Officer of Health for St. Marylebone.

"Water taken from stagnating ponds, with their organic contents in a state of most active putrefaction, and emitting the most repulsive odour, may be deprived of every trace of unpleasant smell, instantaneously, and by comparatively small quantities of manganate and permanganate of potash and soda. The destruction of the organic matter, that is, its conversion into the last products of transformation, is well marked by the rapid decolorization of the deep emerald or purple solution of the manganate or permangate, as the case may be. On allowing the brown sediment of binoxide of manganese to subside, the waters which I examined had become perfectly clear and colourless, retaining no odour whatever, or, in extreme cases requiring a large quantity of the disinfectant, but the slight odour belonging to the alkali present in the manganese salt; and which may be readily removed by the addition of a few drops of an acid. The odour of the water, which in my experiments yielded perfectly to the action of the manganates, was scarcely altered by the use of very considerable quantities of the usual metallic salts. Moreover, the offensive substances are not destroyed by metallic salts, but only fixed; they appear again—the sulphuretted hydrogen by the action of an acid, the ammonia-like compounds by that of a powerful fixed alkali. The manganates and permanganates, on the other hand, destroy the smelling substances completely; containing, as they do, a large quantity of oxygen, the very agent which accomplishes all natural disinfection, they give rise to an actual process of combustion, in consequence of which the cause of the odour or putrefaction is permanently removed."—From Professor Hofmann's *Report of 21st July*, 1856.

"Permanganates of Soda and Potash.—These substances are powerful oxidizers. They are sold under the name of 'Condy's Disinfecting Fluid,' and are exceedingly useful where solid or liquid infectious matters have to be dealt with. They speedily render the matter of cesspools, drains, and sewers perfectly innocuous. They may also be employed *for the purification of water*, and by their action on organic matters can be used *as tests for the purity of water*."—Article Infection in the *English Cyclopædia*, by Charles Knight, 1860.

"The intense red colour of the permanganate solution is readily destroyed by reducing agents; *it thus affords a very delicate test for organic impurities either in water or air.* The extraordinary energy with which it removes those impurities by oxidation, destroying the active agencies of disease the instant it comes in contact with them, finds a parallel only in the

action of the ozoniferous currents of the atmosphere in restoring salubrity after a long period of stagnation and consequent disease. The alkaline effluvia which give their character to the 'close' atmosphere of ill-ventilated dwellings, the miasms of marshy soils, and the deadly reek of putrefying animal matters, have their antidote in this universal purifier. By its action *tainted meat or the foulest water are speedily deprived of all offensive or poisonous matter.* Its effect, when used for the skin, or for rincing the mouth in fevers, &c., is equally wonderful. As a gift of science, constituting a safe guard against disease, this most valuable disinfectant is far from being appreciated [as it deserves]."—*The Electrician*, Nov. 16, 1861.

MUNICH, *July* 19, 1862.

DEAR SIR,

The parcel of permanganate was duly delivered to Dr. von Pfeufer. I have myself made a series of experiments which have convinced me that your statements about the excellent effects of your Disinfecting Fluid in destroying bad smells, as well as the unwholesome contaminations to which drinking water is subject, are perfectly correct. It has proved itself of very great service for purifying the mouth, and washing the feet and other parts of the person. I consider it an inestimable means for the preservation of the health.

Yours truly,

Mr. H. B. Condy, London. J. LIEBIG.

" One of the most thorough methods of oxidation is by the use of the manganates or permanganates They transfer their oxygen to organic substances with great rapidity, and completely destroy them. They are, therefore, complete disinfectants. They destroy the odour of putrid matter rapidly, and oxidize sulphuretted and phosphoretted hydrogen as well as purely organic substances. As they do this by oxidation at a low temperature, they are the mildest form of the destructive disinfectants, and their application to putrid liquids of every kind give the most satisfactory results. Their use has been patented by Mr. Condy."—DISINFECTION in URE'S *Dictionary of Arts, Manufacturers, and Mines*, 1860.

" The air test recommended by Dr. R. Angus Smith, Miss Nightingale, and others, is the alkaline permanganates, or ' Condy's Fluid,' which, besides, is itself a vehicle of ozone, and, as a free contributor of it, is in extensive use as a sanitary

agent identical in its nature with the very ozone of the atmosphere itself—the great scavenger and cleanser of nature."—*The Builder*, 6th July, 1861.

"Just as without the use of the thermometer no nurse should ever put a patient into a bath, so should no nurse, or mother, or superintendent, be without the air test in any ward, nursery, or sleeping-room."—Miss Florence Nightingale's *Notes on Nursing*, note, p. 10.

5, Carlton Hill East, St. John's Wood,
June 6, 1859.

In acknowledging the receipt of the sample of your Patent Disinfecting Fluid, I beg to state that I should have earlier made a report had a favourable opportunity occurred of testing its capabilities in highly poisoned atmospheres. I have now, however, much satifaction in bearing testimony to its great value. I consider it by far the best disinfectant hitherto brought before the profession, and have no doubt it but requires to be known to the public generally to insure an extensive patronage.

I am, Sir, your obedient servant,
Mr. Condy, Battersea. H. B. BUNNETT.

"The disinfectant to which I shall direct your attention, and which acts by burning up noxious organic matter, is 'Condy's Disinfecting Fluid,' which is no doubt familiar to you. , . . . Look at the bottle in which I breathed some time since, the colour is nearly destroyed, the permanganate of potash which I employed having burnt out the organic matter; and so this substance, when used as a disinfectant, destroys putrid effluvia by giving over its oxygen to it and burning the organic matter. This can be illustrated. If I allow this fountain to act, the liquid will gradually become totally decolorised, because it burns away the organic matter which is present in the air of the lecture theatre. These permaganates have in consequence of this property become familiarly and extensively useful."—Lectures on some of the Chemical Arts at the Royal Institution, by Professor Lyon Playfair; *Chemical News*, vol. vi, p. 83, August 9, 1862.

21, George Street, Hanover Square,
July 18, 1857.

I have great pleasure in bearing my testimony to the valuable properties of Mr. Condy's "Natural Disinfecting

Fluid." It appears to me useful in an eminent degree, not only when used towards removing the offensive effects of putrid matter, but as a most valuable disinfectant of unwholesome and stagnant water.

The numerous diseases occasioned by impure water are the source of alarm in the metropolis, and the discovery of a harmless agent, and one efficient in purifying water for use, whether for cooking or drinking, is a boon which cannot be too highly estimated; and it is this property for which I especially recommend this disinfectant of Mr. Condy.

W. BREWER, M.D.

Scarf Castle, Lewes Road, Brighton,
Sir, *October* 10, 1857.

Some weeks since you left me a bottle of your Patent Disinfecting Fluid for investigation, which I have carefully tested and applied in every possible way. It is perfectly harmless and more than a common antiseptic or deodorizer; its wonderful effect upon foul and stagnant water is surprising, rendering it quite sweet and fit for use.

I have, therefore, great pleasure in bearing testimony to this valuable and important introduction.

I remain, Sir, truly yours,

H. SCHWEITZER,

H. B Condy, Esq., *Analytical and Experimental Chemist.*
Battersea.

"We were present on Saturday at the performance of some extremely interesting, and, at this particular time, very valuable experiments in deodorizing sewage water. The experiments were carried on by Mr. Condy, at his extensive chemical works near Battersea Bridge, and consisted of tests by his patent disinfectant. The effect was most instantaneous, the disinfectant causing the destruction of the putrescent organic matter on the moment of its application."—*Morning Herald* July 5, 1858.

"Nothing it may be added, could be more complete than the success of the fluid in rendering the impure water upon which it acted clear and devoid of all offensive odour. How far it would tend to solve the great Thames problem it is for the proper authorities to determine."—*Times,* July 5, 1858.

"Test of the Purity of Water.—All water is liable to two kinds of impurities:—1. Inorganic or mineral substances; 3. Organic or vegetable and animal substances.

"The organic impurities of water are those which are most dangerous, as these substances may ferment or putrefy, and on coming into contact with the mucuous membrane of the stomach, or when taken into the blood, may induce disease. Some of the most frightful ravages of cholera have been clearly traced to the drinking of water contaminated with animal and vegetable impurities.

"These impurities are either *dissolved* or *suspended* in the water. The latter may be detected by being allowed to subside, and their nature can be accurately ascertained by the aid of the microscope; they are found to consist of living and dead animal and vegetable matter. The relative quantity of dissolved and suspended organic matter can be easily tested by the aid of permanganate of potash [Condy's Fluid]. This substance, which gives to pure water a beautiful pink colour which lasts for a long time, is readily decomposed by organic matter, and its colour goes. It my be thus employed for the purpose of detecting the relative impurity of two or more waters. A certain quantity of the permanganate of potash being added to equal quantities of different waters, that water will be *the freest from organic impurities* which retains the deepest colour of the permanganate. Waters which rapidly decompose the permanganate are not fitted for drinking purposes."—Paper issued by the Government Department of Science and Art for Popular Information.

Reports from Surgeons Superintending in the service of the Government Emigration Board.

"The purpose for which I found it most useful was for purifying the drinking water. I used it scantily for other purposes, as it was so extremely useful for this one, for which the other disinfectants are wholly unsuitable and improper."

ARTHUR WHITE,
Surgeon Superintendent, "*Daphne*,"
22*nd January*, 1859.

"It has one advantage over all others in purifying fresh water for drinking purposes."

R. ROBERTSON,
Surgeon Superintendent, "*Wellington*,"
2*nd May*, 1859.

Sir, *Sydney*, 1*st August*, 1860.

In answer to your favour of March last, respecting a supply of your Disinfecting Fluid sent on board the ship "Chance,"

at Southampton, bound for Sydney, with Government emigrants, I beg to inform you, that having given it a fair trial during the voyage, I consider it to be the *best disinfecting agent at present in use*, especially for pouring down the air-holes and pump wells, as it not only *destroys the noxious effluvia but also appears to supply a portion of the grand desideratum, oxygen, so much needed in crowded between decks.*

I have also found it beneficial as a lotion (in a diluted form) in old and indolent ulcers, especially when occurring in patients of a scorbutic diathesis.

I have recommended it in my report, to the Commissioners for Emigration, and hope to see it introduced in all emigrant ships.

I have the honour to be, Sir,
Your most obedient servant,
J. C. SANGER, M.D.,
Late Surgeon Superintendent of the ship "Chance."

Mr. Condy.

SHIP, "ROYAL ALBERT," TABLE BAY,
SIR, *15th March*, 1861.

I have given your Disinfecting Fluid a fair trial on board this ship, and have made a report on it to Her Majesty's Emigration Commissioners, in the following terms:—

"As a deodorizer and general purifier, I consider it invaluable, it having proved perfectly effectual in every case in which I have used it; and I imagine that there are few places where a fair trial can be more readily given to an agent of this kind than on the 'tween decks of an emigrant ship.

"Not the least important of the purposes for which I have found it most useful, is the purification of foul drinking water, for which all other disinfectants with which I am acquainted, are unavailable, either on account of their poisonous nature or disagreeable odour."

Your obedient servant,
PONSONBY ADAIR,
Surgeon Superintendent of the ship "Royal Albert."

Mr. Condy, Battersea.

GOVERNMENT EMIGRATION BOARD,
8, PARK STREET, WESTMINSTER, S.W.,
SIR, *12th November*, 1861.

I have to acknowledge your letter of the 15th ultimo, and in reply to state that the Commissioners have received an additional report from the Surgeon Superintendent of one of their emigrant ships, in which he speaks in highly favourable terms of "Condy's Disaffecting Fluid," both as a general deodorizer and purifier of foul drinking water.

The Commissioners have accordingly authorized their emigration officers to place that preparation on the official list of medicines and other sanitary substances, sanctioned for use on board private passenger ships.

I am, Sir,
Your obedient servant,
Mr. H. B. Condy. S. WALCOTT.

The authorization alluded to in the last testimonial was issued in addition to the order by which the Emigration Commissioners require a certain quantity of Condy's Fluid to be supplied to *all* vessels chartered by them, according to the list annexed to their charter party, and constitutes a further proof of approval of this preparation by the Government Board of Emigration.

Northern Hospital, Liverpool,
Sir, *February* 22, 1858.

Having been requested to state my opinion of your fluid, as applicable or desirable for use on board ships, I have much pleasure in saying, that the results obtained at this Institution have been so satisfactory, both for general disinfecting purposes, and as a local application to wounds and ulcers in a state of gangrene, that I have no hesitation in offering my opinion, that it is peculiarly adapted for use on board ships carrying passengers and going long voyages. As a disinfectant, I consider it superior to any I have ever used.

W. B. WALL, M.R.C.S.,
House Surgeon.

Southern Hospital, Parliament Street,
Liverpool, *February* 23, 1858.

Having had further opportunities of trying the effects of "Condy's Patent Fluid," both as a general disinfectant, and also as applied to sloughing sores, I have no hesitation in recommending it as a most admirable article for use on board ship, and think that its more general use in the merchant service would tend greatly to the preservation of health of the seamen throughout long voyages.

JOSEPH JOHN POPE, M.R.C.S., &c.,
Senior House Surgeon.

S. S. CANADA, *February* 26, 1858.

This is to certify, that I have employed "Condy's Patent Fluid," and found it the best disinfectant I ever used for purifying water-closets, ice-houses, and state rooms on board ship.

H. CHRISTIE,
Chief Steward.

LIVERPOOL, *June* 17, 1858.

I can testify to the complete destruction, by "Condy's Fluid," of the smell of guano in the "Salem," and I am the owner of that ship.

J. G. STUART.

HAVRE, 28*th October*, 1861.

I hereby certify that, having used "Condy's Disinfecting Fluid" during several months on board the steamer "Balbec" trading between Liverpool and Havre, for the closets and bilge water, I have found it very superior to every other disinfectant which I have employed or seen used during a career of forty years in the Royal Navy and Merchant Service.

EDWARD LE FEUVRE,
Steward.

LONDON, 4*th November*, 1861,
28, FINSBURY CIRCUS, E.C.

"Condy's Disinfecting Fluid" has been now for a considerable time tried on the medical deck at the Seamen's Hospital Ship "Dreadnought," for ordinary disinfecting purposes, and I may say, with unquestionable success. It has also been found, when duly diluted with water, to be of great service as a disinfecting and stimulating gargle in various affections of the mouth and throat.

STEPHEN H. WARD,
Physician to the Seaman's Hospital "Dreadnought," &c.

[No. 551.] *From* DR. ANDERSON, M.D., *Superintending Surgeon, Presidency Circle, to* DR. N. CHEVERS, M.D., *Secretary, Director General, Medical Department.* (No, 404, *dated the 2nd December*, 1859.)

I have the honour to enclose, for the information of the Director General, Letter No. 191 of the 29th November, 1859, from DR. SCRIVEN, First Assistant-Surgeon of the General Hospital, reporting favourably on "Condy's Patent Fluid," as a disinfectant and deodorant.

From Dr. J. B. Scriven, *First Assistant-Surgeon. General Hospital, Fort William, Calcutta, to* Dr. J. Anderson, *Superintending Surgeon.*

I have the honour to report upon two jars of "Condy's Patent Fluid," sent for trial for the Government Dispensary, that it has been daily used in cleansing the General Hospital necessaries with decidedly beneficial effect. It has been employed with particular advantage for washing sloughing ulcers, and as a gargle in cases of scurvy.

29*th November*, 1859. (Signed) J. B. SCRIVEN, M.D.

No. 456 of 1859.

From the Director General Medical Department to the Secretary to Government, Military Department.

Sir, *Dated* 21*st February*, 1859.

Adverting to your Letter, No. 712, of the 26th January, 1858, and No. 6,083, of the 16th September, 1858, I beg to report that the Condy's Disinfecting Fluid sent out by the Honourable Court of Directors for trial and report has been distributed with the greatest advantage. I have received from the several medical officers who have made use of this Patent Fluid the highest testimonials in its favour, *as the best article of its kind ever introduced.* The Surgeons of the European General, Jamsetjee Jeejeebhoy, and Artillery Hospitals at the Presidency, state that Condy's Fluid has been used with perfect success in destroying the offensive odour of substances, and is an excellent application to foul sores and fœtid ulcers. The same favourable reports have been received from out stations, and *nearly all concur in considering it superior to the Chloride of Zinc, as a deodorizing and disinfecting agent.*

I beg to recommend that the Home Government be solicited to send out a further supply of Condy's Patent Fluid, and that I may be permitted to direct the Medical Storekeeper to indent upon England yearly for a sufficient quantity.

I have, &c.,

(Signed) B. P. ROOKE,

Director General to Medical Department.

Bombay, 21*st February*, 1859.

(True Copy) (Signed) P. M. MELVILLE, Colonel,

Secretary to Government.

SUR LES

Propriétés Désinfectantes et Thérapeutiques

DES

PERMANGANATES ALCALINS.

ACADÉMIE IMPÉRIALE DE MÉDICINE.

Séance du 17 *Septembre,* 1861.

PRÉSIDENCE DE M. ROBINET.

VII. M. Boudet offre à l'Académie un Mémoire imprimé de M. Henry B. Condy sur les propriétés désinfectantes et thérapeutiques des permanganates alcalins.

Il expose à cette occasion les observations suivantes :— Un chimiste anglais, M. Henry B. Condy, m'a prié de présenter à l'Académie quelques exemplaires d'un opuscule dont il est l'auteur et qui me paraît trés digne d'attention. M. Condy m'a été adressé par mon savant ami M. Pelouze, qui a été frappé lui-même de l'intérêt que ce travail devait offrir pour l'Académie de Médicine. Voici de quoi il s'agit :

On sait depuis les recherches de Schönbein et Houzeau que l'oxygène ozoné, l'oxygène actif, l'oxygène naissant, constitue une seule et même substance qui jouit de propriétés chimiques très énergiques : on sait aussi que l'oxygène ozoné existe naturellement dans l'atmosphère, qu'il y joue nécessairement un rôle considérable au point de vue de la respiration des animaux, que les émauations organiques le détruisent et qu'on peut à peine constater sa présence dans l'air des grandes villes, tandis qu'il se trouve en proportion notable dans l'air des campagnes.

Cet oxygène connu et étudié depuis longtemps déjà comme agent chimique, n'a encore reçu que je sache, aucune application thérapeutique de quelque importance ; c'est à ce dernier point de vue que M. Condy l'a considéré, et il signale les permanganates alcalins et notamment le permanganate de potasse, comme une source d'oxygène naissant qui offre les conditions les plus favorables pour son emploi.

L'action oxydante de ce composé est telle qu'il brûle rapidement les matières organiques partout où il les rencontre et qu'il peut ainsi servir à la purification de l'air et de l'eau, à indiquer la présence, et même à doser les proportions des

matières organiques qui s'y trouvent. N'ayant aucune odeur, étant inoffensif lorsqu'il est en dissolution étendue, ne donnant après son action, que des produits inoffensifs eux-mêmes, il peut être appliqué à l'économie aussi bien à l'intérieur qu'à l'extérieur sans inconvénient.

M. Condy prévoit et signale une foule de circonstances dans lesquelles ce sel lui semble appelé à rendre les plus grands services comme moyen de désinfection ou d'assainissement et surtout comme agent thérapeutique, entre les mains des médecins des chirurgiens et des vétérinaires. Jouissant à un très haut degré de la propriété de modifier et même de détruire les matières organiques et spécialement celles qui sont en voie de décomposition ou de fermentation, quelles ressources ne doit-il pas offrir pour le traitement des plaies et des ulcères, pour les déterger, les assainir, les modifier, pour prévenir ou arrêter les effets de la contagion, pour combattre les affections diphthéritiques, pour modifier ou détruire les productions anormales, les sécrétions nuisibles et même certaines substances veneneuses dans les organes digestifs?

L'opuscule de M. Condy fait entrevoir une multitude de cas dans lesquels le permanganate de potasse ou les autres permanganates alcalins peuvent devenir un agent thérapeutique très précieux, et il appelle sur ce remarquable composé l'attention la plus sérieuse de tous les hommes qui sont voués à l'art de guérir. Le but de M. Condy, en signalant dans son mémoire les nombreuses applications dont cet agent est susceptible, est de répandre une idée utile et de provoquer de la part des médecins, des chirurgiens et des vétérinaires des expériences qui peuvent conduire à des résultats d'une très-haute importance.

C'est parceque j'ai été frappé de ces considérations que j'ai crus devoir entrer devant l'Académie dans quelques développements en lui présentant le travail de M. Condy.

Bulletin de l'Académie Impériale de Médecine, t. XXVI, p. 1267.

[*By the same Author.*]

Disinfection and the Prevention of Disease

BY MEANS OF

OXYGEN IN THE NASCENT OR OZONIC STATE.

CONTENTS:—Influence of Ozone on the Human Economy—Relation of the Alkaline Permanganates to Ozone—Application to Disinfection of the Destructive Action of those Salts on Organic Matter—Account of their valuable Hygienic Properties—their importance as Sanitary Agents in the Prevention of Disease.

[*Preparing for Publication.*]

SUR LES

Propriétés Désinfectantes et Thérapeutiques

DES

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